Employees back at BASF after chemical release

by Melissa Shriver

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MARION COUNTY, MO. (AP) -- Things are back to normal at BASF, after a chemical release evacuated employees and shut down traffic on the nearby Mississippi.

BASF and the Missouri Department of Natural Resources tell KHQA the problem began Tuesday morning, when a chemical called sulfur trioxide was released into the atmosphere due to a mechanical malfunction. When combined with water, this chemical forms sulfuric acid. Sulfuric acid is harmful to people if it's inhaled, swallowed or touches skin. It is also corrosive and can cause burns.

The release of sulfur trioxide was discovered in BASF's sulfuric acid recovery plant around seven o'clock Tuesday morning. It's believed to have been caused by a mechanical problem in the kiln area, which recovers sulfuric acid for use in the manufacturing process.

When that happened, BASF tells KHQA 30 contractors and workers were evacuated from the area downwind of the release as a precaution. A small manufacturing facility downwind of the release site also was evacuated. Because of its proximity to the Mississippi River, the U.S. Coast Guard also stopped river traffic for two hours as a precaution. The release was brought under control around ten in the morning, but not before two to three hundred pounds of the sulfur trioxide was released into the atmosphere.

Was there ever a danger to people?

Missouri Department of Natural Resources Spokesperson Judd Slivka said, "No. The air is safe and the public health was never really threatened. Based on the modeling we've seen the affected area would have been at the most 500 yards from the dispersal point. So there wasn't any danger for people upwind. Given the relatively small amount of sulfur trioxide that was coming from the stack over a period of time and the weight of the trioxide, it didn't go very far."

Slivka says the small amount of sulfur trioxide released into the air over three hours was about the equivelant of having a faucet on in your house, that was more than a drip but less than a stream. But due to the direction of the wind, we asked whether this would affect the Mississippi or the water supply of communities downstream.

Is there any danger to the river or drinking water?

Slivka said, "Not in those concentrations. The Mississippi river is running at 250 thousand cubic feet per second and so it wouldn't be an issue for drinking water right now. If there were an issue it would have been in air quality and since there was such a relatively low amount dispersed there wasn't a threat to air quality."

BASF plans a complete investigation to determine the cause of the incident, to keep it from happening again.

We spoke to Adams County Emergency Management Director John Simon Tuesday. He said even with the wind direction, there was no threat of the sulfur trioxide reaching the Quincy area, because the chemical dispersed within 400 yards from the plant. Simon says the distance from the BASF plant to the Quincy city limits is about seven miles.

UPDATE: 2:20 p.m. Tuesday, March 23rd

The river has been re-opened to traffic after being closed due to a chemical release at BASF near Palmyra.

Officials with the Missouri Department of Natural Resources says sulfur trioxide was released into the atmosphere due to a mechanical malfunction on the kiln crews were using.

When combined with water, sulfur trioxide forms sulfuric acid.

Sulfuric acid is harmful to to people if it's inhaled, swallowed or touches skin. It is also a corrosive and can cause burns.

Due to the release, about 30 contractors and workers were evacuated from the area downwind of the release as a precaution.

Emergency response teams immediately started working to mitigate the release and it was brought under control at approximately 10 a.m.

The release occurred in the site's sulfuric acid recovery plant, which recovers sulfuric acid for use in the manufacturing process.

It is not yet known how much sulfur trioxide was released. Air monitoring was started by BASF personnel.

No offsite impact has been detected.

All law enforcement and regulatory agencies were notified.

A complete investigation will be done to determine the root cause of the incident and corrective actions needed to prevent a recurrence.

Adams County Emergency Management Agency Director John Simon says there is no threat of the sulfur trioxide reaching the Quincy area. Simon says the is no required action on our part due to the release at the BASF plant. He says the health threat from the release is approximately 400 to 500 yards from the actual point of release. Simon says the distance from the BASF plant to the Quincy city limits is about seven miles.

UPDATE: 11:55 a.m. Tuesday, March 23rd

We just spoke to Adams County Emergency Management Agency and executive director John Simon says there is no threat of the sulfur trioxide reaching the Quincy area.

Simon says the is no required action on our part due to the release at the BASF plant.

He says the health threat from the release is approximately 400 to 500 yards from the actual point of release.

Simon says the distance from the BASF plant to the Quincy city limits is about seven miles.

The Missouri Department of Natural Resources is responding this morning to the report of an on-going air release of sulfur trioxide from the BASF plant in Palmyra.

The department was notified this morning by plant officials that the plant began venting the gas about 8 a.m., and the release was continuing through mid-morning.

The department has dispatched an emergency environmental responder from its Macon office to the scene to help determine the extent of the release and possible human health and environmental effects.

When mixed with water, sulfur trioxide becomes sulfuric acid.

BASF officials have evacuated the plant and neighboring industries. As a precaution, the U.S. Coast Guard has stopped traffic on the Mississippi River between mile markers 325 and 318.

Prevailing winds from the southwest are carrying the vented gas over a primarily rural area of Illinois. The department has contacted both the U.S. Environmental Protection Agency office that covers Missouri as well as the Illinois Environmental Protection Agency.

The department has also notified Marion County emergency management officials.

A copy of the Material Safety Data Sheet for sulfur trioxide may be found at http://www.sciencelab.com/msds.php?msdsId=9925153

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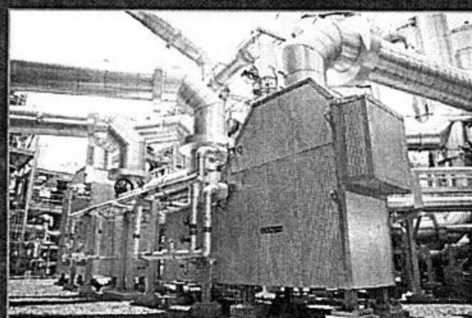
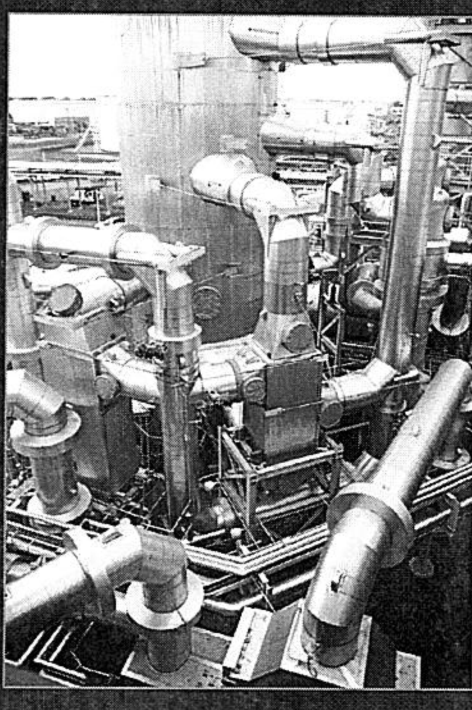
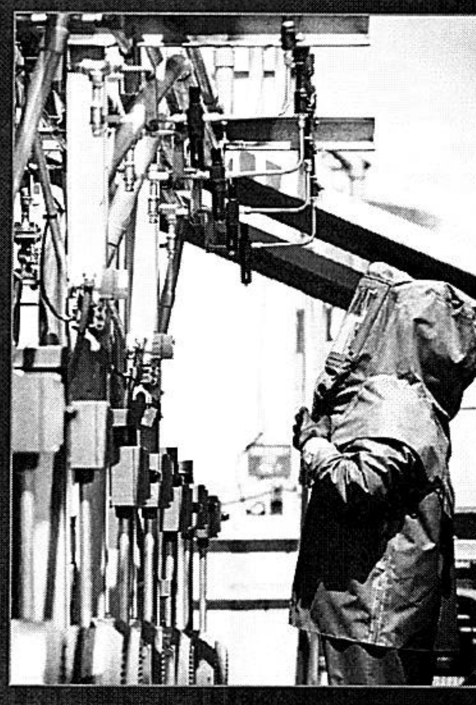
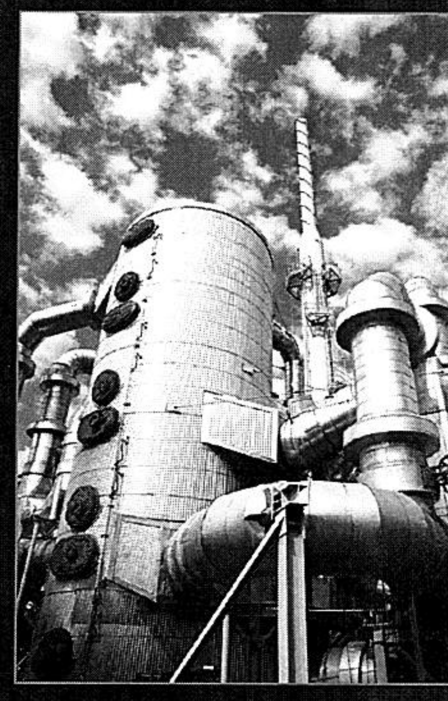


DuPont Clean Technologies — Helping reduce industry impact on the world environment Page 9







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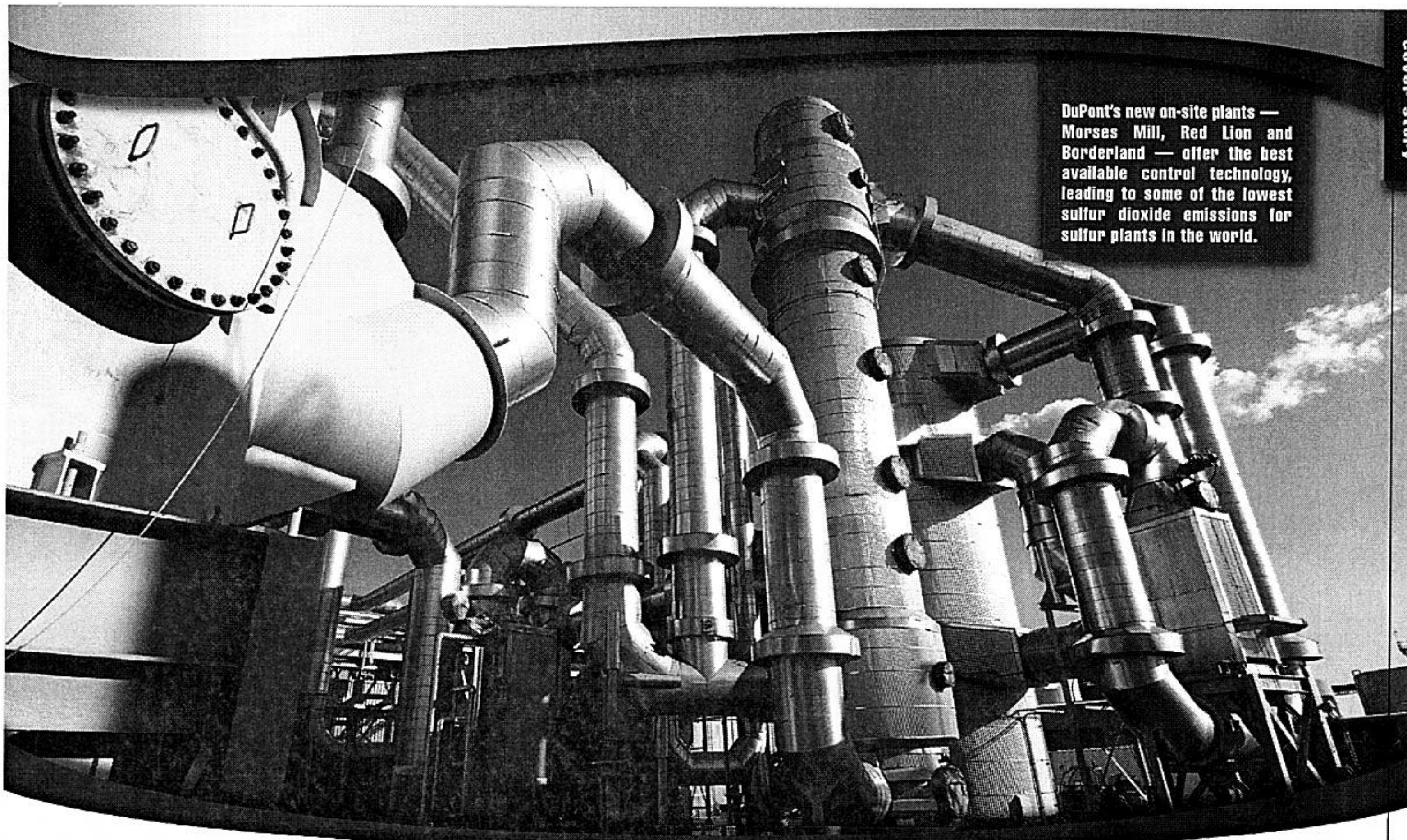


DuPont's new on-site plants — Morses Mill, Red Lion and Borderland — offer the best available control technology, leading to some of the lowest sulfur dioxide emissions for sulfur plants in the world.

DuPont Clean Technologies – Helping reduce industry impact on the world environment

Rooted in science and driven by an adaptable nature, DuPont has navigated over two centuries as a science-based industry leader. The DuPont name has remained a constant as its products – chemicals, materials, environmental technologies, sustainable products and services – have evolved to meet the pressing needs of the day.

As a company known for "putting science to work," DuPont is committed to environmental health and safety, while keeping a focus on innovative processes, science-based services and products that help keep its customers' operations running efficiently. Today, that means delivering a combination of profitability and cleaner technologies – something that helps DuPont reduce the impact it and its green-minded customers have on the environment.

DuPont Chemical Solutions Enterprises (DCSE), a part of the company's Safety & Protection business, is a standard-bearer within DuPont for sustainable solutions. One of the newest business units within that group is DuPont Clean Technologies.

"We have a real commitment to the sulfuric acid business," Steve Burtch, global business director for DuPont Clean Technologies said. "From our beginnings as a commodity supplier to an integrated, sustainable solutions provider, we bring over 100 years of experience in the safe and reliable operation of sulfuric acid plants. Today, we have aspirations to be a global, billion-dollar business by helping to take environmental challenges off the plate of refiners so they can better focus on their core business."

Building blocks for a cleaner, safer tomorrow

Through the experience and technology housed in DuPont Clean Technologies, DuPont offers its customers – with a strong focus on refinery based enterprises - future-focused solutions. The company has dedicated itself to improvements in the areas of clean air and clean fuel, and this has led the company to seek out like-minded industry partners and complementary technologies. From the reduction of sulfur oxides (SOx), nitrogen oxides (NOx) and particulate emissions to technologies that support the production of clean fuels, DuPont resources deliver a broad range of clean and green services.

DuPont operates eight sulfuric acid manufacturing facilities in the United States with sites at Delaware City, DE; El Paso, TX; Linden, NJ; Wurtland, KY: North Bend, OH; Richmond, VA; Burnside, LA: and LaPorte, TX. In recent years, DuPont has honed proprietary techniques and acquired new resources to support its sulfur facilities and its efforts in the refining sector. Its integrated environmental solutions roster currently features STRATCO®, BELCO® and IsoTherming® technologies as well as capabilities in Spent Acid Regeneration (SAR) and Sulfur Gas Recovery (SGR).

"Our customers are focused on cleaner burning fuels. They are dedicated to a cleaner environment and we are dedicated to helping them achieve this goal through our technologies," Lisa Bolten, global business manager for STRATCO®, BELCO® and IsoTherming® said.

One of the world leaders in sulfuric acid alkylation technology, STRATCO® became part of the DuPont family in 2003. BELCO®, a leader in air quality control for refineries, was acquired in 2006.

With STRATCO®, DuPont was able to supplement its sulfur expertise with alkylation knowledge and advance its acid service and repair offering. Since the 1920s, STRATCO® has been involved in the research and development of alkylation technology, including initial development of the sulfuric acid alkylation process. For decades, the company has assisted refiners in the research, design, start-up, test running, troubleshooting, revamping, and expanding of alkylation units for refinery facilities. Today, an overwhelming majority of alkylation units are licensed and designed by STRATCO® — a testament to the company's technological strength.

"The BELCO® brand is well recognized for supplying air quality control systems for more than 15 years to the oil refining, sulfur recovery and sulfuric acid industries," Bolten noted. The BELCO® "all-in-one" approach provides full control-enabling regulatory compliance for NOx, SOx and particulate emissions. Both reliable and flexible, the technology can be modified as requirements or regulations change.

The experience of STRATCO® and BELCO® also complements DuPont Clean Technologies' international aspirations. Burtch noted that DuPont will "go where the growth is," adding that the business currently works with international refiners and plans to increase its global presence.

A new offering from DuPont Clean Technologies is IsoTherming® hydroprocessing technology — a unique technology suited to reducing sulfur in motor fuels. IsoTherming® involves a novel reactor system that is superior to conventional hydrotreating technologies. For the refiner, this technology offers reduced capital costs and lower annual operating costs while dramatically reducing sulfur content in motor fuels.

The use of on-site sulfur management systems, through Spent Acid Regeneration - Sulfur Gas Recovery (SAR-SGR) is another route for DuPont to meet refinery customers' need to use higher sulfur crude feedstocks and reduce sulfur oxide emissions. The company relies upon leading-edge technology for these new installations, and has used innovative process technology with its most recent start ups. This high-tech, on-site model allows for a DuPont built, owned, operated and maintained SAR-SGR plant to be constructed either adjacent to or on the site of a refinery.

The SAR-SGR technology offers an improvement in the design of, and an alternative to, the Claus tail gas treatment. The plant configuration provides optimal use of all processes and products, including sour water stripper and acid gases as fuel in the spent regeneration process. The plant can also process a variety of chemical spent sulfuric acid.

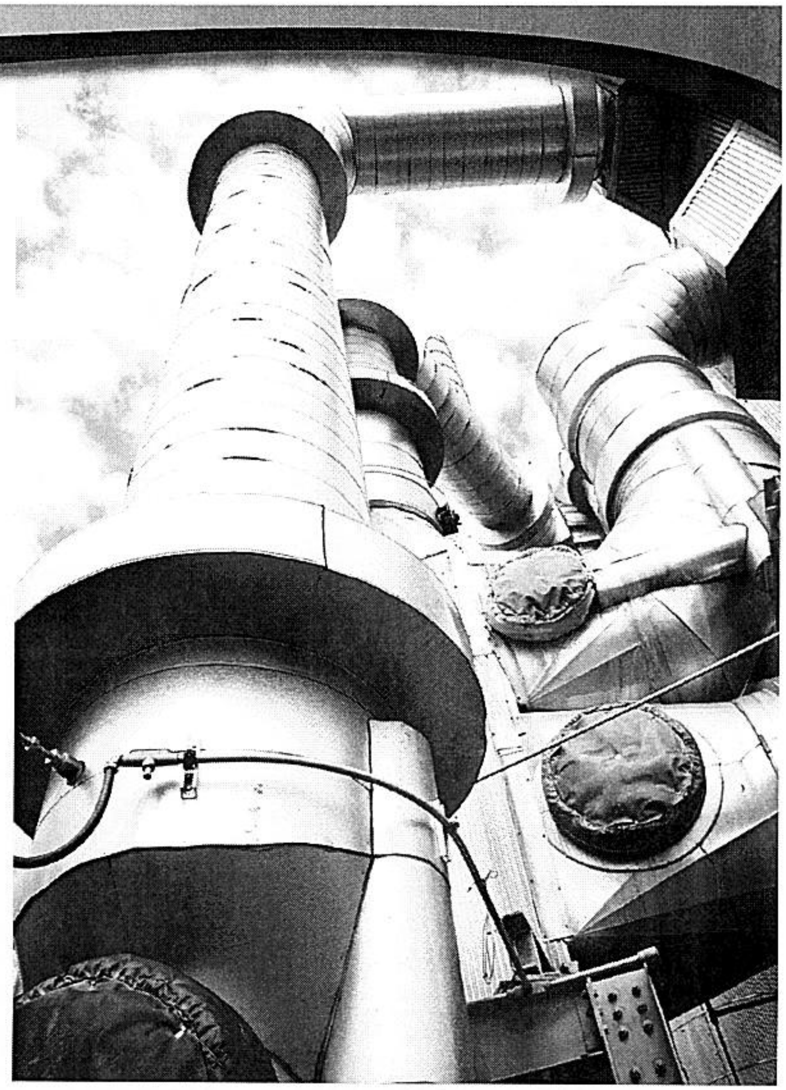
Among the multitude of companies jockeying for position with fuel refiners, DuPont's core legacy with sulfur products gives it a unique leg up on the competition. There is no question that DuPont is a committed member of the sulfur industry - their decades-long history with fuming acids, sulfuric acid and spent acid regeneration is not debatable.

"One thing we can provide to the customer is that sense of staying power in the industry and that sense of commitment and reliability," Burtch said. "We have made a very substantial investment in this business. We have operated acid plants for a long time and our operating record in areas such as employee and process safety, management systems and reliability remains very strong."

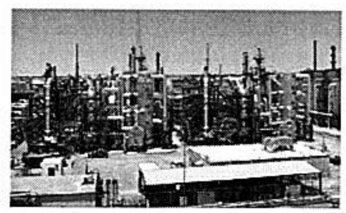
Spreading the knowledge, sharing expertise

To become a true steward of environmental improvement, DuPont recognizes it must step outside its own walls and share its experience with others. For that reason, the company's product offerings are not strictly limited to technological applications. Through its Global Engineered Solutions (GES) group, DuPont is replicating the successful operation of DuPont facilities to consumers around the world. With consulting and on-site services, DuPont Clean Technologies is bringing its technical and scientific standards of excellence to other companies engaged in sulfuric acid plant operation and maintenance.

"Through our GES business we have extensive operating expertise to offer sulfuric acid plants; including sulfur burning plants, spent acid regeneration plants and metallurgical off-gas plants," Burtch said.



The GES offering is powered by a highly skilled staff of sulfuric acid technical professionals with nearly 500 years of combined experience. DuPont's GES services are available 24 hours a day, seven days a week, to assist plants with any operational, maintenance or technical challenges. Services are focused on sulfuric acid plants and alkylation units, and include everything from mechanical integrity assessments, process and operational troubleshooting to reliability engineering, emergency response training, plant start-up assistance, operator training and more.



DuPont's Borderland plant features an integrated on-site SAR-SGR facility that provides acid regeneration services and processes all of the high-strength sulfur bearing gases from Western Refining.

Steve Burtch, global business director for DuPont Clean Technologies

Denise Kopko, business manager for DuPont Clean Technologies, Sulfur Products

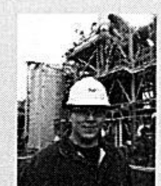
Lisa Bolten, global business manager for STRATCO®, BELCO® and IsoTherming®

Kelly Kober, DuPont Acid Technology Center manager

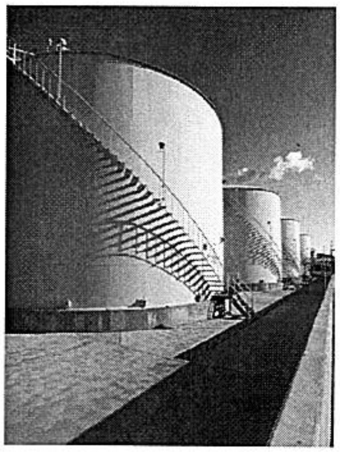
Judy Del Tosto, Red Lion plant manager

Dave Everett, Borderland plant manager

Joe Hausler, Morses Mill plant manager



Jeff Carhart, Red Lion operator



Red Lion's sulfuric acid storage tanks.

"We have more than 20 people based geographically in the United States to support our sites," Kelly Kober, DuPont's Acid Technology Center's manager, said. This highly skilled, rapid-response group easily adapts to innovative concepts. "For example," Kober noted, "if we find a new inspection process, or a vendor comes up with a new product, we can quickly modify that to all of our sites. We have the ability to take our engineers and make them specialists in that area."

From that point, the new process is shared and implemented throughout the company's internal sites, its product customers and others utilizing GES services.

The value of GES for a customer using sulfuric acid technology often comes down to numbers. According to Kober, a typical acid plant performs a shutdown every two to three years. The individuals employed by the facility, even with a career of 12-15 years at the site, will see only a few shutdowns throughout their tenure. "So we have the ability to go into a plant – whether it's for the fertilizer industry or the basic sulfuric acid industry – conduct an assessment and perform inspections internally and externally. Then we can judge how long that piece of equipment will last, suggest material changes and recommend repairs to extend that equipment's life, or recommend research of innovative technology to take that plant from one place to another," Kober said.

Through a close association with DuPont Safety Resources (DSR), GES is also able to provide safety and operational excellence solutions. These involve safety assessments, asset productivity, capital effectiveness and sustainability operations. The DSR group also helps GES provide customers with integrated solutions to make facilities operate most profitably with minimal environmental footprints, energy consumption and risk. Across the sulfuric acid industry, problems crop up at facilities that, while unique to that plant's experience, have common threads. If a plant experiences NOx or SOx issues, is struggling on a tank or piping inspection or is looking to develop a good preventative program, GES can move in quickly and help address all of the issues.

"We feel we are a good fit, not only for a grass-roots plant, but also for retrofits." Kober said. "Since we have the access and understanding of the various technologies, we look for the ability to meld one piece with another for existing plants.

Beyond the concept – DuPont Clean Technologies in action

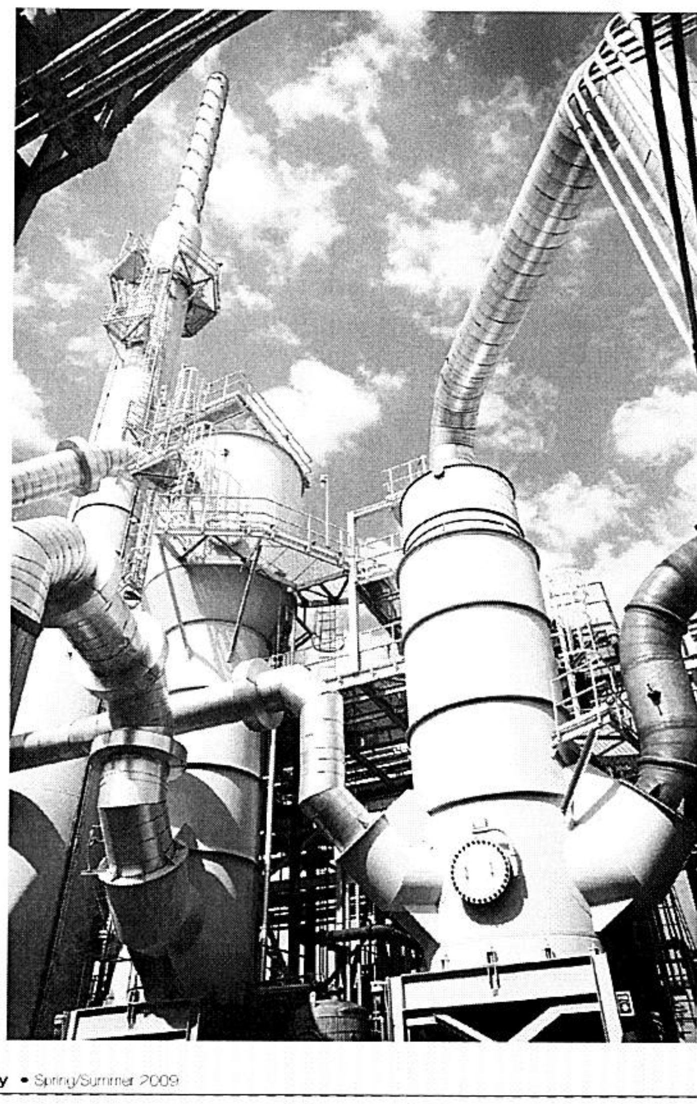
With eight sulfuric acid manufacturing facilities scattered around the United States and numerous clean technology applications, DuPont's facilities are as unique as the locations they inhabit. However, the new SAR-SGR plants share one important attribute – site refinery customers work with DuPont to help manage the environmental and sulfur-related challenges that can distract a refiner's attention from the core business of fuel production. The challenges of decreasing emissions while increasing the utilization of higher sulfur crudes, operating a unit to produce a valued product from sulfur-containing streams, and providing a highly reliable source of sulfuric acid for alkylation with less management of logistical issues are addressed and resolved by bringing together a host of DuPont technologies and services that best answer specific refinery needs.

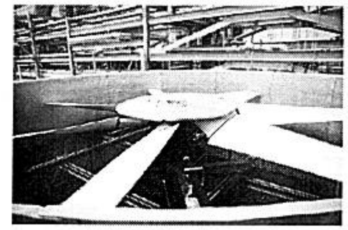
Denise Kopko serves as business manager for DuPont Clean Technologies, Sulfur Products; a post that grants her a broad perspective on the entire DuPont acid business.

In the new SAR-SGR plants, science has advanced the sulfur gathering process beyond the Claus gas unit. "We take their acid gas instead of sending it to a Claus gas unit," Kopko said. "We take it directly to our plant and make sulfuric acid"

These modernizations have enabled the refineries served by DuPont's Borderland and Morses Mill plants to eliminate their reliance on Claus units.

The company's new on-site plants offer the best available control technology as well, leading to some of the lowest sulfur dioxide emissions for sulfur plants in the world. Also, the new plant sites do their part to further reduce the carbon footprint by eliminating transportation as well as using a non-carbon fuel source for much of the heat required to operate them.





Morses Mill cooling tower fan blade.

"In the past, we were moving product from Delaware City, DE., all the way to Burnside, LA.," Kopko said.

"In addition, DuPont operates sulfur burning plants where we bring in sulfur and make sulfuric acid, oleum, sulfur trioxide (SO_3) and chlorosulfonic acid (CSA)" she added.

Oleum, CSA and SO_3 are also produced in the Ohio Valley, going to customers for use in a broad range of products such as surfactants, flame retardants and shampoos. Large quantities of fuming acids and sulfuric acids are shipped from this region as well.

On the spent regeneration side, Kopko designates the Burnside site as the "cornerstone" plant. The location handles spent acid regeneration, SO_3 and sulfuric acids. The site, which was constructed in 1967, has just completed a significant plant upgrade, divided into two main projects – reliability and dual absorption.

"This was a huge project — the largest this site has seen," Kopko said, "and the teamwork was phenomenal."

Whether working with new on-site plants or retrofitting clean options to the legacy sites, Kopko relies heavily on the strength and know-how of the DuPont nationwide team and the creativity and agility of the "small plant mentality." This potent combination helps in the development of specific environmental solutions that allow refinery customers to turn their attention to their core business.

"Our employees have a 'can do' way of thinking," she said. "We have a tremendous acid technology center. When a plant has a problem, we have the resources and knowledge to bring to the table quickly."

The variety of plant configurations calls for an ownership and commitment from the plant personnel – and Kopko contends they never fail to deliver. "No matter what function they are in, everyone always pulls together," she said.

Plant Spotlight: Borderland

The Borderland site, located in El Paso, Texas, was built from the ground up utilizing DuPont technology. The plant, a collaboration with Western Refining, features an integrated, on-site SAR-SGR facility that provides acid regeneration services and processes all of the high-strength sulfur bearing gases from the refinery. This replaces the existing Claus-tail gas units, making Borderland (along with the DuPont site in Linden, N.J.) among the world's lowest-emitting sulfuric acid plants.

Morses Mill operator on his rounds conducting safety checks.

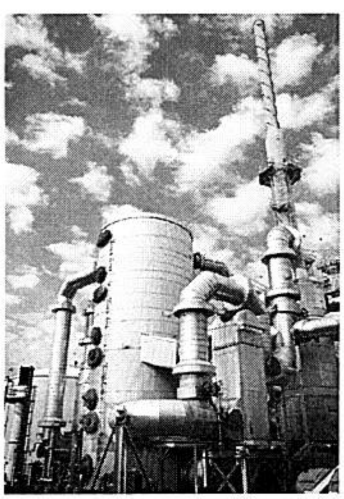
The new plant concept found root in Western Refining's need to upgrade its sulfur technology.

"We looked into building a sulfur plant ourselves and continuing to import sulfuric acid by rail, but there were issues associated with the physical movement of so much acid," Ken Jinkerson, Western Refining Vice President, said.

After reviewing the options, and researching a potential partnership, Western Refining chose to build with DuPont. "We chose DuPont after taking a closer look into their business strategy and track record of reliability. They addressed all of the issues that we were facing and then some," Jinkerson said.

The DuPont-Western Refining collaborative called upon 30-year DuPont veteran Dave Everett to serve as plant manager. Everett joined the staff early to plan for Borderland's post-construction operations including start up, hiring of staff and the implementation of all DuPont procedures.

Ken Jinkerson, Western Refining vice president



"This has been the experience of a career," he noted. "How many people get the opportunity to build a brand new plant and see it all the way through to hiring and training?"

The entire job took 18 months, from breaking ground to start up.

"To be able to receive sulfur-bearing streams from the refinery on a regular basis with minimal interruptions, we actually built two plants — two trains instead of one plant," Everett said. The first train came online in February 2008, followed by the second train that April.

"If we're not running, the refinery is not running and that is a significant issue," Everett added. "Inside of each plant we have redundancy on almost every critical piece."

By effectively lowering sulfur dioxide emissions, the new plant has created efficiencies for the environment and the refiners. With the sulfur technology handled, Western Refining is now free to focus on its core business of processing oil.

"Before, they had to deal with unloading and loading of acid cars, storing acid, loading sulfur cars and running the Claus units," Everett said. "These items are now what DuPont deals with on a daily basis."

"The integration between the two companies has been seamless," Jinkerson added. "We know that our livelihoods depend upon us being on the same page with one another. With the process we've been through – we would recommend DuPont to anyone. It's been a good marriage of the two companies."

In addition to communicating with each other, the Borderland facility also keeps in close contact with its neighbors through its Community Advisory Panel. Meetings are held once a month to share and address any issues.

"We feel this partnership has been a win for DuPont, a win for Western Refining and a win for the El Paso community," Everett said.

Plant Spotlight: Red Lion

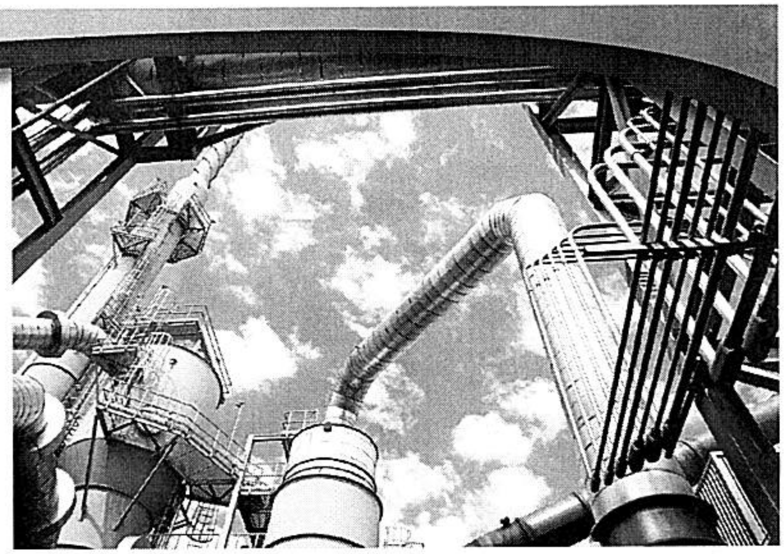
Located in Delaware City, DE, the DuPont Red Lion SAR plant began operation in August 2005 at a refinery that was owned by Motiva and Premcor, before being acquired by the current owner – Valero. Though new to the DuPont name, Red Lion's unique characteristics have propelled the site into a regional supplier of sulfuric acid.

"One impressive aspect about this site is that it is very efficient," Jeff Carhart, Red Lion operator, said. "Almost all of what we have generates something else that is used – almost nothing is wasted."

According to Carhart, whenever possible every pass and process is reused to the full extent of technology. "The superheater is a heat exchanger and its primary goal is to cool the gas before it goes to the gas cleaning system. However, in the process, we can generate high pressure steam which we sell to the refinery."

Plant Manager Judy Del Tosto, a 22-year DuPont veteran, credits Red Lion's

Located in Delaware City, DE, the DuPont Red Lion SAR plant began operation in August 2005.



Since DuPont's Red Lion facility uses sulfur-containing gas streams as a feedstock, the facility has shown an approximate reduction of 180 tons per year of sulfur dioxide air emissions and 2,700 tons per year of (sulfate-containing) wastewater to the local environment.

strong and steady rise to a commitment to continuous improvements.

"The Red Lion team has focused on a better understanding of how to control the process which has allowed them to increase the production rates of sulfuric acid and comply with environmental regulations," she said. "Preventative maintenance of the equipment has permitted high uptime which allows us to better meet customer requirements."

Delivering a superior quality product to the customer is top priority for Del Tosto and her staff, but adherence to the company's four core values – Safety and Health, Environmental Stewardship, Highest Ethical Standards and Respect for People – are vital to the process.

"Working safely and achieving zero injuries or incidents is what drives us daily," Del Tosto stated. "The entire Red Lion team is involved in achieving these safety goals." Strong auditing and a superior Process Safety Management System (PSM) keep Red Lion on the right path.

On the environmental front, Red Lion understands the value of regulations. "It is critical that we run our operation in compliance with environmental regulations," Del Tosto said. Of note is that since the Red Lion facility uses sulfur-containing gas streams as a feedstock, the facility has shown an approximate reduction of 180 tons per year of sulfur dioxide air emissions and 2,700 tons per year of (sulfate-containing) wastewater to the local environment.

Community involvement in the regulatory and response process is another key component of environmental policy. "The community is very aware of what we produce at Red Lion," Del Tosto said. "We recently had a drill at Red Lion which involved outside responders from the community. This allowed the community an opportunity to see the plant in action first-hand and understand that we operate an environmentally safe plant."

In recent months, Red Lion also performed its first major shutdown. The project included the work of numerous contractors – with as many as 65 contractors working on the site at any one time. During this shutdown Red Lion performed no less than 100 vessel entries – all in keeping with core values by conducting them safely and without any incident or injury.

"The hazards of vessel entries are very high. However, due to the preplanning and open communications with everyone at the site, we achieved our goal of zero injuries and incidents in the shutdown," Del Tosto said.

With a successful turnaround behind them and a secure spot as a leading supplier for the region, Del Tosto has set her sights on long term relevance for the facility.

"My goal for the Red Lion facility is that it remains in operation for many years and that all employees can retire from this plant," she said. For Del Tosto, that longevity is bound to the core values. "We will continue to be one of the most competitive SAR producers of sulfuric acid. We will continue to be one of the lowest cost producers and be able to meet our customer demands. I want this plant to achieve zero injuries and zero environmental incidents for many years to come."

A sustainable trend

As the worldwide population increases, the consumption of fossil fuels will rise as well. The end result will be a greater need for environmental stewardship and a greater demand for lower sulfur fuels produced with lower emissions. Everything is trending toward a safer, more environmentally responsible world.

According to Burtch, the ideals of the DuPont Clean Technologies group mirror those of the global society.

"DuPont offers the technologies and services that help control refinery emissions and address the production of low sulfur-containing fuels," Burtch said. "By providing integrated solutions that maximize synergies between technologies, minimize cost to the refiner and offer the lowest environmental footprint — we give customers the freedom to focus on their core business." ❑

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Since the facility's start-up in 1967, DuPont Burnside has grown to become an integral part of the chemical industry in Louisiana. We supply products and services to industry throughout the region.

Refineries use the high strength sulfuric acid produced at Burnside to produce gasoline. Sulfuric acid is also used to produce many other familiar products such as metals, rubber, paint, paper, plastics, pharmaceuticals and food. Sulfur trioxide, another form of sulfuric acid, is also produced at Burnside. It is used to manufacture household products like detergents and shampoo.

In addition to producing valuable products, Burnside also provides important services. One such service is the regeneration of spent acid. Spent acid refers to sulfuric acid that has been used and diluted by refineries and some chemical companies. Burnside regenerates this spent acid by using it as a raw material. Nearly half of Burnside's production comes from the regeneration of spent acid. The remaining production comes from sulfur removed from crude oil by refineries.

Burnside also participates in Fuming Acid Seminars provided by DuPont for its customers. These seminars promote safe handling and use of acids by providing training and advanced knowledge of hazards.

Process Overview

Spent acid from our customers is shipped to the Burnside plant by barge, rail car and tank truck. This acid contains impurities and excess water. Concentrating and purifying this acid would require tremendous amounts of energy. Instead, the acid is converted to sulfur dioxide and water, which are much easier to separate. At the same time, molten sulfur is burned in a large furnace to create both. The spent acid and the sulfur are then reacted with oxygen to create sulfur trioxide. A catalyst is used to promote this reaction. This can either be purified and shipped by rail car directly as product or it can be added to weak acid to make high strength acid. High strength acid is shipped by truck, rail and barge.

DuPont is committed to the safety of the environment and the community, including their employees. It exhibits this commitment by meeting or exceeding safety and environmental guidelines set forth by the Occupational Safety and Health Administration and the Environmental Protection Agency. DuPont strives to maintain its reputation as a pacesetter in safety, health and protection of the environment by setting goals of zero incidents and injuries. By continuing to provide valuable products and services, and maintaining its commitment to safety and the environment, it hopes to continue it role as a key contributor in both the Louisiana chemical industry and the Louisiana economy.

For More information contact:
http://www.dupont.com

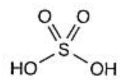
SITE MAP

Strong Inorganic Acid Mists Containing Sulfuric Acid

CAS No. 7664-93-9 (Sulfuric acid)

Known to be human carcinogens

First listed in the *Ninth Report on Carcinogens* (2000)



Sulfuric acid

Carcinogenicity

Strong inorganic acid mists containing sulfuric acid are *known to be human carcinogens* based on sufficient evidence of carcinogenicity from studies in humans.

Cancer Studies in Humans

Occupational exposure to strong inorganic acid mists containing sulfuric acid is specifically associated with laryngeal and lung cancer. Studies of one U.S. cohort of male workers in pickling operations in the steel industry found excesses of laryngeal cancer (approximately twofold) after adjustment for smoking and other potentially confounding variables (Steenland *et al.* 1988). A ten-year follow-up of this cohort also found a twofold excess of laryngeal cancer, consistent with the earlier findings (Steenland 1997). The same cohort showed an excess of lung cancer after adjustment for smoking and other potentially confounding variables (Steenland and Beaumont 1989). A nested case-control study of workers in a U.S. petrochemical plant found a dose-related increase in the risk of laryngeal cancer among workers exposed to sulfuric acid at moderate levels (odds ratio [OR] = 4.6; 95% confidence interval [CI] = 0.83 to 25.35) or high levels (OR = 13.4; 95% CI = 2.08 to 85.99) (Soskolne *et al.* 1984). A Canadian population-based case-control study also found a dose-related risk of laryngeal cancer for workers exposed to sulfuric acid mist, after controlling for tobacco and alcohol use and using only the most specific exposure scale (Soskolne *et al.* 1992). A similar Canadian population-based case-control study suggested an increased risk of lung cancer (oat-cell carcinoma) (Siemiatycki 1991).

Additional Information Relevant to Carcinogenicity

The manufacture of isopropyl alcohol by the strong-acid process, which uses sulfuric acid, has been classified by the International Agency for Research on Cancer as carcinogenic to humans, based on increased incidence of cancer of the paranasal sinuses in workers (IARC 1977). The carcinogenic activity of sulfuric acid is most likely related to the genotoxicity of low-pH environments, which are known to increase the rates of depurination of DNA and deamination of cytidine (IARC 1992a).

Cancer Studies in Experimental Animals

No adequate studies in experimental animals of the carcinogenicity of sulfuric acid or strong inorganic acid mists containing sulfuric acid have been reported in the literature.

Properties

Sulfuric acid is a strong acid that is a clear, colorless oily liquid at room temperature. Impure or spent sulfuric acid is a dark-brown to black liquid. Sulfuric acide is soluble in water and ethanol and is very corrosive (IARC 1992b). Physical and chemical properties of sulfuric acid are listed in the following table.

Property	Information
Molecular weight	98.1[a]
Density	1.8 g/cm^3 [a]
Melting point	10.31°C[a]
Boiling point	290°C[a]
Log K_{ow}	1.92[b]
Vapor pressure	5.93×10^{-5} mm Hg at 25°C[a]
Vapor density relative to air	3.4[a]
Dissociation constant (pK_a)	1.98 at 25°C[a]

Sources: [a]HSDB 2009, [b]ATSDR 1998.

A mist is defined as a liquid aerosol formed by condensation of a vapor or by atomization of a liquid. Strong inorganic acid mists containing sulfuric acid may be generated during a process when factors such as evaporation, solution strength, temperature, and pressure combine to result in release of a mist (IARC 1992a). Sulfuric acid mists are the most extensively studied of the acid mists. Liquid sulfuric acid may exist in air as a vapor or a mist; however, it exists most often as mist, because of its low volatility and high affinity for water.

Acid strength is based on the position of equilibrium in an acid-base reaction and is measured by the negative logarithm (to the base 10) of the acid dissociation constant (pK_a). The lower the pK_a, the stronger the acid. Sulfuric acid has two pK_a values because it releases two hydrogen atoms in aqueous solution, but the first pK_a cannot be measured accurately and is reported as less than 0. Dehydration occurs because sulfuric acid has a strong affinity for water. It forms various hydrates when in contact with organic matter or water vapor. Although it is miscible with water, contact with water generates heat and may produce a violent reaction. The reaction with water releases toxic and corrosive fumes and mists. Sulfuric acid is noncombustible, but it can release flammable hydrogen gas when in contact with metals. Thermal decomposition to sulfur trioxide and water occurs at 340°C. Sulfuric acids are available in the following grades: commercial, electrolyte (high purity), textile (low organic content), and chemically pure or reagent grades (IARC 1992b, ATSDR 1998, HSDB 2009).

Sulfur trioxide is added to sulfuric acid to produce fuming sulfuric acid (also known as oleum). Oleum has a molecular weight of 178.1, may contain up to 80% free sulfur trioxide, and is a colorless to slightly colored oily liquid. Sulfur trioxide has a molecular weight of 80.1 and can exist as a gas, liquid, or solid. Liquid sulfur trioxide is colorless and fumes in air at ambient conditions. In the presence of moisture, sulfur trioxide forms solid polymers consisting of alpha and beta forms. The melting points of the alpha (62.3°C) and beta (32.5°C) forms are the temperatures at which they depolymerize back to the liquid form. The liquid form has a boiling point of 44.8°C and a density of 1.92 g/cm^3 at 20°C. Both oleum and sulfur trioxide react with water and water vapor to form sulfuric acid mists. Oleum is available in several grades with free sulfur trioxide content ranging from 20% to 99.9% and corresponding sulfuric acid equivalents ranging from 104.5% to 122.5%. Sulfur trioxide is available with a minimum purity of 99.5% as a stabilized technical grade or unstabilized liquid (IARC 1992b).

Use

Strong inorganic acid mists containing sulfuric acid are not used *per se* in industry or in commercial products but are generated from both natural and industrial sources. In particular, sulfuric acid mists may be produced during the manufacture or use of sulfuric acid, sulfur trioxide, or oleum. Sulfur trioxide is primarily used to make sulfuric acid, but it is also used as a sulfonating or oxidizing agent. Oleum is used as a sulfonating or dehydrating agent, in petroleum refining, and as a laboratory reagent. Sulfuric acid is one of the most widely used industrial chemicals; however, most of it is used as a reagent rather than an ingredient. Therefore, most of the sulfuric acid used ends up as a spent acid or a sulfate waste. Exacting purity grades are required for use in storage batteries and for the rayon, dye, and pharmaceutical industries. Sulfuric acids used in the steel, chemical, and fertilizer industries have less exacting standards (IARC 1992b, ATSDR 1998, HSDB 2009).

Sulfuric acid is used in the following industries: fertilizer, petroleum refining, mining and metallurgy, ore processing, inorganic and organic chemicals, synthetic rubber and plastics, pulp and paper, soap and detergents, water treatment, cellulose fibers and films, and inorganic pigments and paints. Between 60% and 70% of the sulfuric acid used in the United States is used by the fertilizer industry to convert phosphate rock to phosphoric acid. All other individual uses account for less than 1% to less than 10% of the total consumption. Sulfuric acid use is declining in some industries. There is a trend in the steel industry to use hydrochloric acid instead of sulfuric acid in pickling, and hydrofluoric acid has replaced sulfuric acid for some uses in the petroleum industry. The primary consumer product that contains sulfuric acid is the lead-acid battery; however, this accounts for a small fraction of the overall use. Sulfuric acid is also used as a general-purpose food additive (IARC 1992b, ATSDR 1998).

Production

Strong inorganic acid mists containing sulfuric acid may be produced as a result of the use of mixtures of strong inorganic acids, including sulfuric acid, in industrial processes such as acid treatment of metals, phosphate fertilizer manufacture, and lead battery manufacture (IARC 1992b). The degree of vapor or mist evolution varies with the process and method. In pickling, for instance, mist may escape from acid tanks when hydrogen bubbles and steam rise from the surface of the solution.

Sulfuric acid is the largest-volume chemical produced in the United States (CEN 1996). Annual production increased from 28.3 million metric tons (62.4 billion pounds) in 1972 to 40.1 million metric tons (88.4 billion pounds) in 1980 (IARC 1992b, ATSDR 1998). Between 1981 and 2002, annual production remained fairly steady, ranging from a low of 32.6 million metric tons (71.9 billion pounds) in 1986 (IARC 1992b) to a high of 44 million metric tons (97 billion pounds) in 1998 (CEN 2003). Between 1992 and 2002, annual production declined by only 1% (CEN 2003). Many different grades and strengths of sulfuric acid are produced. The primary method of production is the contact process, which consists of the following steps: (1) oxidation of sulfur to sulfur dioxide, (2) cooling of the gases, (3) oxidation of sulfur dioxide to sulfur trioxide, (4) cooling of the sulfur trioxide gas, and (5) addition of sulfur trioxide to water to produce sulfuric acid. Oleum is produced at sulfuric acid plants by adding sulfur trioxide to sulfuric acid. In addition to primary production, large quantities of spent sulfuric acid are reprocessed (IARC 1992b, ATSDR 1998). In 2009, sulfuric acid was available from 76 U.S. suppliers, and oleum from 6 U.S. suppliers (ChemSources 2009).

The United States is a net importer of sulfuric acid and oleum. U.S. imports were 275,000 metric tons (600 million pounds) in 1975, 426,000 metric tons (940 million pounds) in 1984, and 2.3 million metric tons (5 billion pounds) in 1993, and exports were 129,000 metric tons (284 million pounds) in 1975, 119,000 metric tons (262 million pounds) in 1984, and 136,000 metric tons (300 million pounds) in 1993 (HSDB 2009). In 2009, imports were about 5 million kilograms (11 million pounds), and exports were 262,000 kg (578,000 lb) (USITC 2009).

Exposure

Human exposure to strong inorganic acid mists containing sulfuric acid may occur by inhalation, ingestion, or dermal contact. Exposure depends on many factors, including particle size, proximity to the source, and control measures such as ventilation and containment. Data on particle size distribution of acid mists are limited, and sampling methods have generally not differentiated between liquid and gaseous forms of acids. One study of sulfuric acid mists in several U.S. battery manufacturing plants found that particles had a mass median aerodynamic diameter of 5 to 6 μm, which indicates that sulfuric acid mists contain aerosol particles that can be deposited in both the upper and lower airways (IARC 1992a).

Sulfuric acid and mists and vapors containing sulfuric acid are present in the environment because of releases of sulfur compounds from both natural and anthropogenic sources. Volcanic eruptions, biogenic gas emissions, and oceans are the primary natural sources of sulfur emissions. Volcanoes release 0.75 million to 42 million metric tons (1.7 billion to 93 billion pounds) of sulfur per year, and airborne sea spray and marine organisms release between 12 million and 15 million metric tons per year (26 billion to 33 billion pounds). Coal combustion by electric plants is the major anthropogenic source of sulfur dioxide release. Sulfur dioxide emissions in the United States declined by more than 60% from the early 1970s (28 million metric tons [62 billion pounds]) to 1994 (18 million metric tons [40 billion pounds]) and decreased by another 13% from 1994 to 1995 (ATSDR 1998).

According to the U.S. Environmental Protection Agency's Toxics Release Inventory, environmental releases of sulfuric acid fluctuated from year to year, but remained in the range of 26 million to 197 million pounds from 1994 and 2007. In 2007, 840 facilities released over 138.5 million pounds of sulfuric acid, of which over 99% was released to air (TRI 2009). Ambient air may contain particulate-associated mixtures of sulfuric acid and ammonium sulfates (sulfuric acid partially or completely neutralized by atmospheric ammonia). The relative amounts of sulfuric acid and total sulfates depend on meteorological and chemical parameters. The presence of sulfuric acid and sulfates in the atmosphere is believed to be due to oxidation of sulfur dioxide in cloud water and other atmospheric media. Ambient-air concentrations of sulfuric acid are at least an order of magnitude lower than concentrations in occupational settings (IARC 1992a).

The industries in which occupational exposure to strong acid mists may occur include chemical manufacture (sulfuric acid, nitric acid, synthetic ethanol, and vinyl chloride), building and construction, manufacture of lead-acid batteries, manufacture of phosphate fertilizers, pickling and other acid treatments of metals, manufacture of petroleum and coal products, oil and gas extraction, printing and publishing, manufacture of paper and allied products, and tanneries. Most of the available occupational exposure data comes from the pickling and plating industries. In the 1970s and 1980s, average concentrations of strong inorganic acid mists containing sulfuric acid in workplace air were less than 0.01 to 7.3 mg/m^3 for pickling and acid cleaning, less than 0.07 to 0.57 mg/m^3 for phosphate fertilizer manufacture, 0.01 to 1.03 mg/m^3 for lead battery manufacture, and less than 0.005 to 0.5 mg/m^3 for other industries (IARC 1992a).

The National Occupational Hazard Survey (conducted from 1972 to 1974) estimated that 499,446 workers were exposed to sulfuric acid, 824,985 to hydrochloric acid, 132,401 to nitric acid, and 454,920 to phosphoric acid (NIOSH 1976). The National Occupational Exposure Survey (conducted from 1981 to 1983), which reported on more than 54,500 plants with potential workplace exposure to strong inorganic acids, estimated that 775,587 workers, including 173,653 women, potentially were exposed to sulfuric acid; 1,238,572 workers, including 388,130 women, to hydrochloric acid; 297,627 workers, including 76,316 women, to nitric acid; and 1,256,907 workers, including 450,478 women, to phosphoric acid (NIOSH 1990).

Regulations

Coast Guard, Department of Homeland Security

Minimum requirements have been established for safe transport of sulfuric acid on ships and barges.

Consumer Product Safety Commission (CPSC)

Sulfuric acid and any preparation containing sulfuric acid in a concentration of 10% or more must have a label containing the word "poison."

Department of Transportation (DOT)

Sulfuric acid and numerous sulfuric acid mixtures are considered hazardous materials, and special requirements have been set for marking, labeling, and transporting these materials.

Environmental Protection Agency (EPA)

Clean Air Act

New Source Performance Standards: Standards of performance have been established for sulfuric acid production units, including a limit on acid mist (expressed as H_2SO_4) emissions of 0.15 lb/ton of acid produced.

Clean Water Act

Sulfuric acid is designated a hazardous substance.

Comprehensive Environmental Response, Compensation, and Liability Act

Reportable quantity (RQ) = 1,000 lb for sulfuric acid.

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Aerosol forms of sulfuric acid are listed and thus subject to reporting requirements.

Threshold planning quantity (TPQ) = 1,000 lb for sulfuric acid.

Reportable quantity (RQ) = 1,000 lb for sulfuric acid.

Resource Conservation and Recovery Act

Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of sulfuric acid = U103, P115.

Occupational Safety and Health Administration (OSHA)

While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2010, specific PELs may not reflect the more current studies and may not adequately protect workers.

Permissible exposure limit (PEL) = 1 mg/m³ for sulfuric acid.

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 0.2 mg/m³ for sulfuric acid contained in strong inorganic acid mists.

National Institute for Occupational Safety and Health (NIOSH)

Recommended exposure limit (REL) = 1 mg/m³ for sulfuric acid.

Immediately dangerous to life and health (IDLH) limit = 15 mg/m³ for sulfuric acid.

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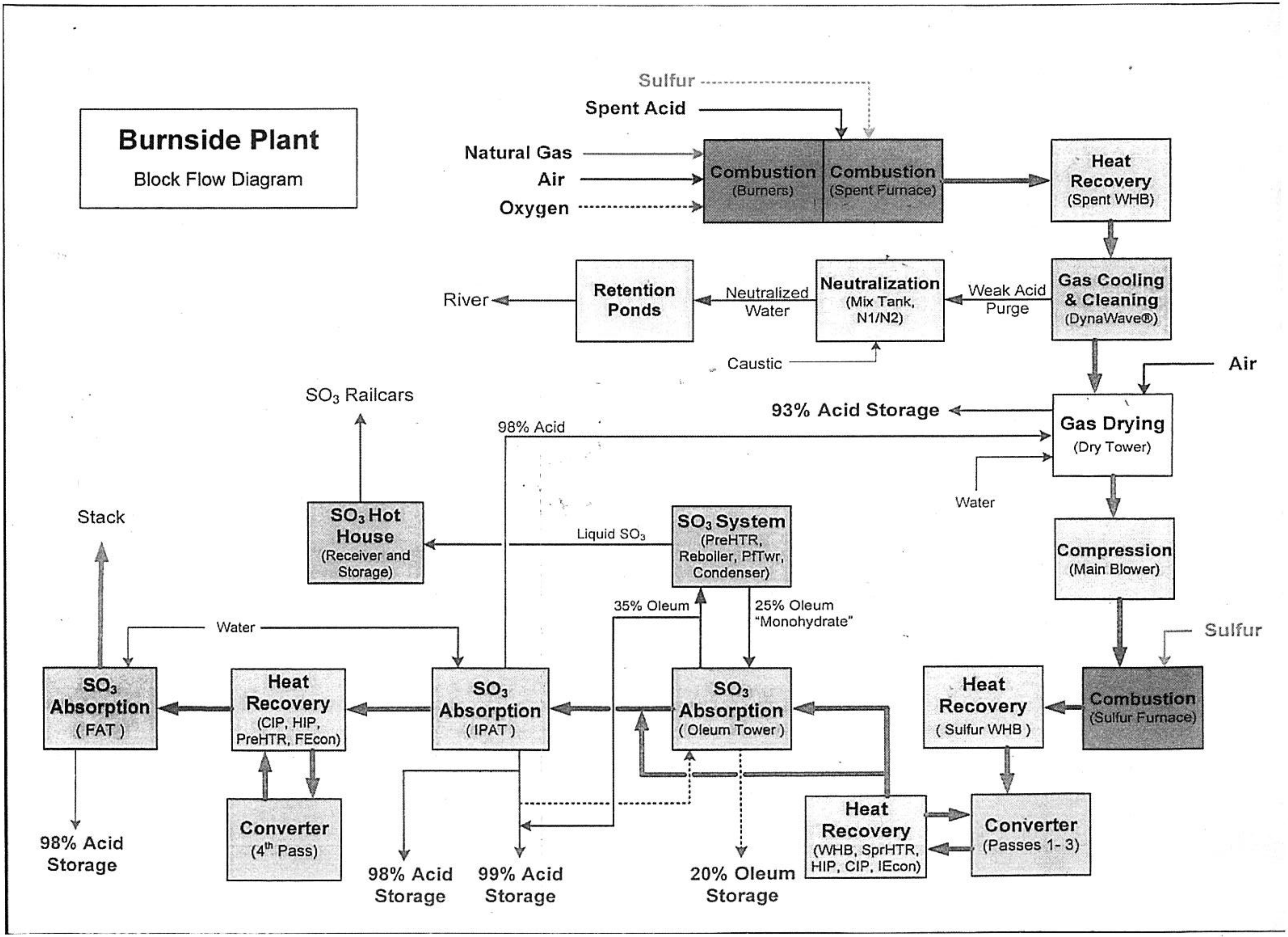

Burnside Plant
Block Flow Diagram
Sulfur
Spent Acid
Natural Gas
Air
Oxygen
Combustion (Burners)
Combustion (Spent Furnace)
Heat Recovery (Spent WHB)
Gas Cooling & Cleaning (DynaWave®)
Weak Acid Purge
Neutralization (Mix Tank, N1/N2)
Caustic
Neutralized Water
Retention Ponds
River
Air
93% Acid Storage
Gas Drying (Dry Tower)
Water
98% Acid
Compression (Main Blower)
Sulfur
Combustion (Sulfur Furnace)
Heat Recovery (Sulfur WHB)
Converter (Passes 1- 3)
Heat Recovery (WHB, SprHTR, HIP, CIP, IEcon)
SO_3 Railcars
SO_3 Hot House (Receiver and Storage)
Liquid SO_3
SO_3 System (PreHTR, Reboiler, PfTwr, Condenser)
35% Oleum
25% Oleum "Monohydrate"
SO_3 Absorption (Oleum Tower)
20% Oleum Storage
SO_3 Absorption (IPAT)
98% Acid Storage
99% Acid Storage
Water
Heat Recovery (CIP, HIP, PreHTR, FEcon)
Converter (4^{th} Pass)
SO_3 Absorption (FAT)
Stack
98% Acid Storage

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Sulfuric Acid Mist: Regulating Uncertainties

Matthew Thurlow*

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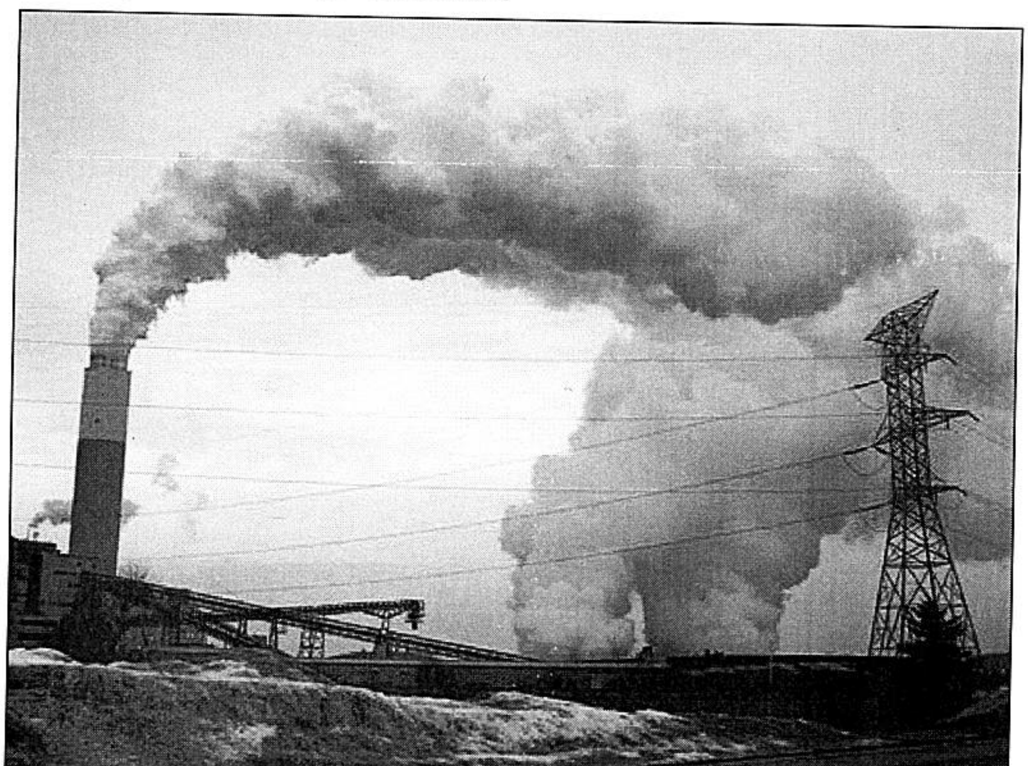
<<< See Update, January 2, 2013, below >>>

Sulfuric acid mist, also known as H_2SO_4 or SO_3,[1] is one of the least publicized air pollutants associated with emissions from coal-fired power plants. Long overshadowed by nitrogen oxides, sulfur dioxide, and carbon dioxide, sulfuric acid mist is typically not emitted in the boundary-crossing and globe-altering quantities of the more frequently discussed air pollutants. In the whirlwind of the United States Environmental Protection Agency's (EPA) recent air regulations of coal-fired power plants including the Mercury and Air Toxic Standards for power plants (MATS), the New Source Performance Standards and the Tailoring Rule for greenhouse gases, and the recently vacated Cross-State Air Pollution Rule, sulfuric acid mist has remained relatively untouched.[2] But EPA's regulations, which have imposed dramatic new emission limits on sulfur dioxide, nitrogen oxides, greenhouse gases, mercury, and hydrochloric acid, are likely to have a significant impact on sulfuric acid mist emission control strategies at coal-fired power plants.[3]



Sulfuric acid mist emissions from coal-fired power plants, which creates tell-tale blue plumes (not pictured here), has increasingly been under scrutiny by the EPA over the past decade. Photo credit to ribarnica.

Although sulfuric acid mist has been recognized as an air pollutant for decades, it only emerged as a significant problem for the utility industry in the early 2000s.[4] In 2001, after the General James M. Gavin Power Plant installed a type of nitrogen oxide controls called selective catalytic reduction devices (SCRs), sulfuric acid mist emissions unexpectedly spiked from 9000 to 11,000 pounds per day to allegedly more than 64,000 pounds per day.[5] In Cheshire, Ohio, a small village of 200 people in the shadow of the Gavin plant, residents reported asthma-like symptoms and noted corrosion and discoloration of paint on cars and houses, as blue plumes of sulfuric acid periodically drifted through the village.[6] The owner of the plant, American Electric Power (AEP), eventually paid $20 million to buy out most of Cheshire. A decade later, the village remains mostly empty.[7]

The utility industry responded to the Gavin incident by investing significant time and money to study the sulfuric acid mist problem.[8] EPA has also responded by paying closer attention to sulfuric acid mist from power plants and bringing a handful of sulfuric acid mist enforcement actions.[9] Current and future enforcement cases involving sulfuric acid mist pose a number of challenges. In cases brought under the Clean Air Act's (CAA) Prevention of Significant Deterioration of Air Quality (PSD) Program, utility companies, regulators, and courts may struggle to determine what emissions limits and controls are required for sulfuric acid mist. This struggle is based on uncertainties about the precise conditions under which sulfuric acid mist forms, how it can be controlled, how emissions can be monitored, and most importantly, at what emissions levels it poses a threat to human health and the environment.

The Gavin incident and subsequent studies have dramatically improved the utility industry's understanding of sulfuric acid mist. Sulfuric acid mist emissions strongly correlate with the sulfur content of coal: the higher the sulfur content, the higher the sulfuric acid mist emissions.[10] But the precise circumstances that result in the formation of sulfuric acid mist have been much more difficult to unravel. Experts believe that vanadium and other constituents in coal may increase sulfuric acid mist formation.[11] In addition, boiler design and oxygen levels in the flue gas appear to influence sulfuric acid mist formation. High temperatures in boilers increase the formation of sulfuric acid mist with the mist forming at the highest levels in a temperature band above approximately 800 degrees.[12] Finally, ambient conditions, including wind and water content in the air, also influence sulfuric acid mist formation and its impacts.[13] This means that even if all other factors remain constant, weather conditions may result in higher or lower ambient concentrations and can increase the risk of human exposure to sulfuric acid mist.

The uncertainties and complexities associated with sulfuric acid mist are further compounded by its relationship to other pollutants. Most troubling, as discovered at the Gavin plant, there is a clear relationship between the use of SCRs to reduce nitrogen oxide emissions and increases of sulfuric acid mist.[14] A study of power plants equipped with SCRs found that 98 percent of the plants were expected to emit sulfuric acid mist at levels above 5 ppm, a level that might result in environmental impacts.[15] But enforcement actions brought against plants that have installed SCRs raise the troubling specter of potentially penalizing utilities for their efforts to reduce their environmental impact. In exercising enforcement discretion, regulators may be forced to balance the need to reduce nitrogen oxides and their regional impacts with the need to protect communities from the more localized impacts of sulfuric acid mist.[16] And as with any pollutant from power plants, industry, government, and the public must weigh the environmental and health benefits of sulfuric acid mist control on one side, versus energy supply and demand and the potential increased cost of electricity on the other. This Article briefly outlines the scientific and legal complexities facing the utility industry and environmental regulators in developing sulfuric acid mist control strategies. Next, it compares the economic and environmental tradeoffs of different control strategies. Finally, it recommends control strategies that provide the utility industry operational flexibility while ensuring that human health and the environment are protected from sulfuric acid mist and recognizes that there may not be a one-size-fits-all solution to reduce sulfuric acid mist emissions at power plants.

I. Regulating Sulfuric Acid Mist Under the Clean Air Act

A. Prevention of Significant Deterioration Provisions

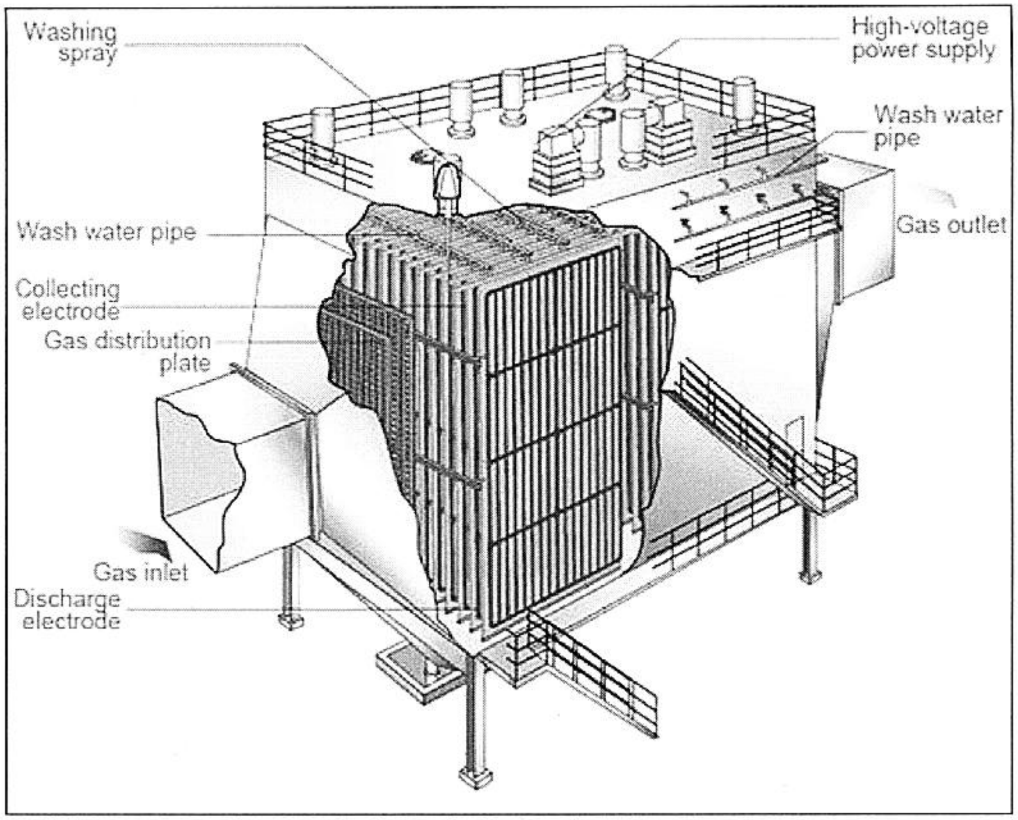
One of the most important avenues for regulating sulfuric acid mist under the CAA is through the New Source Review (NSR) program.[17] Under NSR, major new and modified stationary sources in areas that are unclassifiable or that meet the National Ambient Air Quality Standards (NAAQS) are subject to PSD permitting.[18] Notwithstanding certain exceptions, NSR and PSD are triggered either by new construction, or a physical change or change in the method of operation of an existing facility that results in a significant net increase of emissions of a pollutant. The threshold for "significant increase" varies by pollutant. For sulfuric acid mist, the threshold is an increase of 7 tons per year.[19] Facilities subject to the PSD program must submit a PSD permit to the permitting authority and implement Best Available Control Technology (BACT) for each regulated pollutant. Thus, unless an exception applies,[20] any power plant that makes a physical or operational change to its plant resulting in an increase of sulfuric acid mist emissions of more than 7 tons a year must obtain a PSD permit and apply BACT to limit sulfuric acid mist emissions.

B. Best Available Control Technology

BACT is an emissions limit "based on the maximum degree of reduction of each pollutant subject to regulation under" the CAA "on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs," that the permitting authority "determines is achievable."[21] EPA recommends, and most permitting agencies apply, a top-down BACT analysis that ranks all available control technologies for a regulated pollutant in descending order of effectiveness.[22] Following this approach, the most stringent control alternative is selected unless technical considerations, energy, environmental, or economic impacts lead the permitting authority to conclude that it is not "achievable."[23] Because BACT is assessed on a case-by-case basis, it may differ significantly from one power plant to another power plant. Geography, fuel sources and types, and plant configuration can impact the technical feasibility of controls and the cost effectiveness of controls.[24] Not surprisingly, permitting authorities, the utility industry, and the public, which can comment on PSD permits,[25] may disagree over how technical, environmental, economic, and site-specific factors should influence BACT determinations.

C. Control Technology Available for Sulfuric Acid Mist

One of the most effective control options for sulfuric acid mist is a wet electrostatic precipitator (WESP), a particulate control device that removes particles, including sulfuric acid mist, from flue gas by using an electrostatic charge.[26] WESPs are extremely efficient at removing sulfuric acid mist, but they can cost $50 million to $200 million and require a significant amount of energy, up to 0.5 percent of the plant's gross output, to operate.[27] Because BACT analyses require economic assessment of control options, including a calculation of removal costs on a per ton basis, utilities may effectively argue that a WESP is not required under BACT if the amount of sulfuric acid mist removed is less than several thousand tons per year. There is no bright-line rule for per ton removal costs under BACT, but costs above five or six thousand dollars per ton for controls have been referenced as approaching the upper limit of the threshold of economically feasible technology required under BACT.[28]



A wet electrostatic precipitator. Image credit to Hitachi Plant Technologies, Ltd.

The current preference of the utility industry for sulfuric acid mist control appears to be sorbent injection, an option that is much more economical than WESPs in the short term. Dry sorbent injection uses nozzles to spray a dry powder, typically magnesium, lime, or trona (a sodium-based mixture), into the flue gas.[29] The sorbent binds with the sulfuric acid mist and removes it from the flue gas stream. But there are limits on the use of sorbent control. Excessive use of sorbents can clog equipment, so power plant engineers may need to experiment with different levels of sorbent injection. They may also need to balance sorbent injection with other control methods, including configuration changes that increase the amount of time sulfuric acid mist remains in the stack.[30] The longer the residence time for sulfuric acid mist in the stack, the more opportunity the sulfuric acid mist has to bind with sorbent.[31] Facilities can also maximize sulfuric acid mist control if they mill sorbent into smaller particles that increase the surface area of sorbent and improve its potential to capture sulfuric acid mist. However, even with these measures, there remains a saturation point beyond which increasing the amount of sorbent injected will not further reduce the amount of sulfuric acid emissions. Other plant improvements, including installation of low catalyst SCRs,[32] which reduce, but do not eliminate the impacts of SCRs on sulfuric acid mist formation, or switching or blending fuel with low or medium sulfur content coal,[33] may be used to supplement sorbent injection.

Baghouses, which are large filters designed to capture soot and other particulates,[34] can also reduce sulfuric acid mist emissions. One study indicates that baghouses can remove up to 90 percent of sulfuric acid mist.[35] As with WESPs, however, installing baghouses can be a significant capital expenditure.[36] Utilities may balk at the expense and argue that the technology is not economically feasible under a BACT analysis.

Improvements in sorbent control may be increasing regulators' and industry's confidence that sorbent injection, while not achieving the same reductions in sulfuric acid mist as WESPs, can reduce sulfuric mist emissions to levels that are sufficient to protect human health and the environment at a fraction of the cost.[37] The effectiveness of sorbent injection, however, may depend on proper calibration and maintenance of sorbent injection rates over time and a consistent fuel source. If these inputs are not constant, sulfuric acid mist emissions could spike. To mitigate the possibility of fluctuations in sulfuric acid mist emissions, operators need to build in some compliance headroom by ensuring that day-to-day emissions of sulfuric acid mist are marginally lower than levels that could result in opacity problems or violate permit limits. Once a control strategy has been adopted, power plants and enforcement authorities need to monitor the effectiveness of the controls over time and in different operating scenarios. Some power plants may need to continue to experiment with a variety of controls to find a solution that provides the best balance of sulfuric acid mist reduction, control of other pollutants, and power plant performance.

D. Opacity Violations

The appearance of the tell-tale blue plume of sulfuric acid mist from the stack of a power plant often indicates a different violation of the CAA. In addition to, or in lieu of, claims brought under the CAA's PSD provisions, EPA may bring claims against power plant owners and operators for opacity violations under the Act's New Source Performance Standards (NSPS) (Section 111 of the Act) or the applicable State Implementation Plan.[38] "Opacity means the degree to which emissions reduce the light and obscure the view of an object in the background." 40 CFR § 63.2. At 100 percent opacity, no light is visible through a plume. At zero percent opacity, a plume is completely transparent. While opacity is not itself a pollutant, it serves as a surrogate for particulate matter pollution, including sulfuric acid mist pollution, from power plants.[39]

The NSPS for fossil-fuel-fired steam generators provide that, for power plants constructed after August 17, 1971, gases emitted from the facility cannot "exhibit greater than 20 percent opacity except for one six-minute period per hour of not more than 27 percent opacity."[40] For facilities not subject to the NSPS (built prior to August 1971), opacity limits can vary depending on the applicable State Implementation Plan. In Kentucky, for example, facilities are not to exceed 40 percent opacity except for one six-minute period per hour of not more than 60 percent opacity.[41] In Texas, older facilities cannot exceed 30 percent opacity averaged over a six-minute period.[42]

Opacity problems associated with sulfuric acid mist can occur with emissions as low as 3-4 ppm.[43] The utility industry reports that sulfuric acid mist concentrations of only 10 ppm can result in opacities greater than 40 percent, the upper opacity limit for many older power plant units.[44] Other industry guidance indicates that opacity problems can occur at sulfuric acid mist concentrations above 5-15 ppm.[45] The impacts of sulfuric acid mist emissions on stack opacity can fluctuate depending on operating conditions. Opacity monitors can provide accurate opacity data and send an immediate warning to plant operators if limits are exceeded. But many power plants have had to install wet scrubbers to address sulfur dioxide emissions, which makes it difficult or impossible to monitor opacity within their stacks. As a result, many plants have either removed their opacity monitors or replaced them with particulate monitors. Continuous sulfuric acid mist monitors, which would best address the current monitoring problem, are still under development.[46]

As a result of the unavailability of effective monitoring devices for sulfuric acid mist, in many instances the only method to determine opacity at a power plant is through visual observation of the plume. Method 9 readings, which rely on the judgment of a trained inspector, are the most common method of visual opacity assessments.[47] Although inspectors are typically experienced and well trained, Method 9 is subject to judgment, memory, and the human eye.[48] Inspectors record 24 consecutive observations (typically in six-minute increments) and average the results. An accurate opacity test requires ideal weather conditions because the plume cannot be clearly observed on cloudy days. The difficulty and uncertainty associated with visual opacity readings are a cause for concern for both regulators and the industry.[49] On the one hand, regulators have to undertake opacity readings onsite and in clear weather to document opacity violations. On the other hand, an opacity reading made by a regulator visually assessing real time emissions from memory is difficult for a defendant to refute.

If a pattern of opacity violations at a power plant can be established, EPA or state environmental authorities may argue that significant controls are required to eliminate the visible sulfuric acid mist plume. Enforcement authorities may obtain civil penalties for each day a plant exceeds opacity limits, or obtain significant injunctive relief that, in some cases, approaches a BACT-like remedy.

II. Human Health and the Environment and Emissions Limits

Perhaps the thorniest issue with regard to regulating sulfuric acid mist is determining at what levels emissions of sulfuric acid mist threaten human health and the environment. Studies indicate that sulfuric acid mist can impact the health of children with asthma at 70 micrograms per cubic meter, and can impact normal adult lung function at 100 micrograms per cubic meter.[50] The impact on health, however, is a function of exposure duration, individual sensitivity, and exposure to other air contaminants.

West Maple Street at Route 7, Cheshire, Ohio, 2002. Photo credit to Franz Jantzen. Mr. Jantzen photographed various locales in Cheshire, Ohio once a year between 2002 and 2004, when American Electric Power bought up much of the land in the the town in response to complaints by residents of severe sulfuric acid mist pollution. Mr. Jantzen returned one final time in 2009. NPR and Architizer both published blog posts on Jantzen's Cheshire, Ohio Project.

In the early 2000s, toxicologists from the Agency for Toxic Substances and Disease Registry evaluated the impacts of sulfur dioxide and sulfuric acid mist on the village of Cheshire, Ohio, near the Gavin power plant, and concluded that emissions posed a public health hazard to some residents.[51] The highest officially recorded levels of sulfuric acid mist in Cheshire were approximately 120 micrograms per cubic meter of air, but there were unofficial reports of levels as high as 200 micrograms per cubic meter of air.[52] It was difficult for investigators to determine the duration of individual exposure to sulfuric acid mist, but exposures ranged from several minutes to several hours.[53] Residents in Cheshire were also exposed to high levels of sulfur dioxide and metal oxide particulates and investigators indicated that the presence of these and other co-contaminants might also have had health impacts.[54]

Following the lawsuit brought by Citizens Against Pollution, AEP agreed to emissions limits of 14 ppm of sulfuric acid mist at the Gavin plant. By comparison, in the only settled case to date in which EPA has directly addressed sulfuric acid mist, involving the Hoosier Energy Company, the parties agreed to limits of approximately 2.5 ppm (.007 lb/mmBTU).[55] But this limit was only one part of a larger settlement that required a number of significant improvements to the facility at a total cost of $250 million to $300 million.[56] Additionally, Hoosier had a lengthy compliance period, almost two years, to meet the sulfuric acid mist emissions limit, and an additional year before it was subject to stipulated penalties to meet these limits.

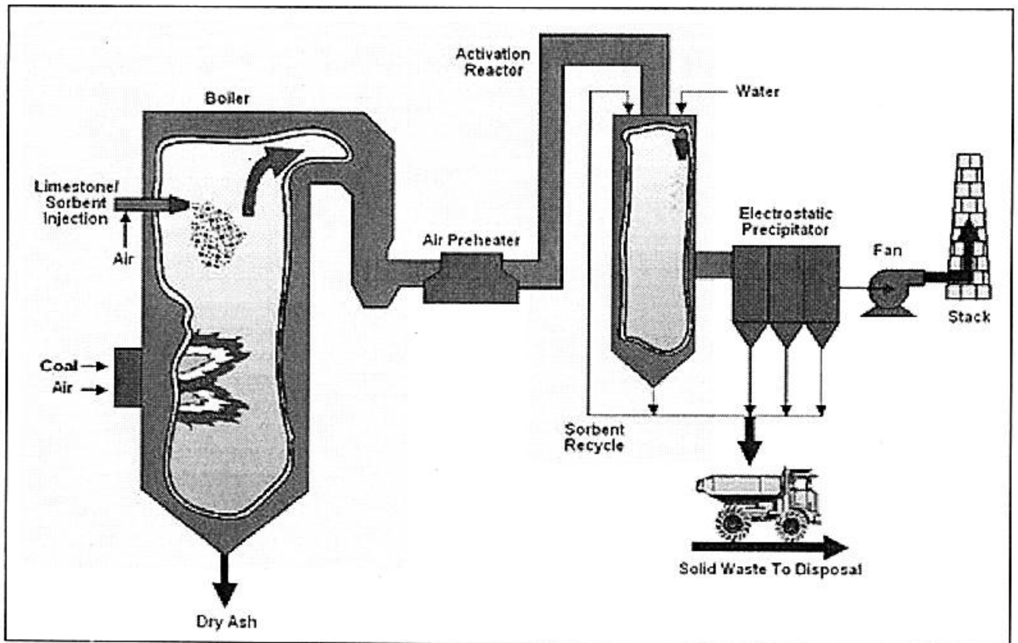
Although there appears to be some consensus in the utility industry that emissions of sulfuric acid mist above 5 ppm may result in opacity problems, many power plants may be disinclined to agree to similarly low limits. This hesitation is in part a function of the difficulty of measuring sulfuric acid mist.[57] Although there is an accepted EPA methodology for stack testing for sulfuric acid mist, the industry has expressed concern that this method does not provide accurate results.[58] Sulfuric acid mist emissions also may fluctuate between stack tests. While sorbent controls may ensure compliance with a 5 ppm limit most of the time, ambient conditions or variations in fuel could result in higher emissions.[59] Both EPA and the industry are concerned that no continuous emissions monitoring device is commercially available for sulfuric acid that has the requisite sensitivity to detect changes of less than 1 ppm in the stack.

In the absence of recurrent, visible opacity problems, power plants may remain unaware of the potential significance of sulfuric acid mist emissions until stack testing can be performed, at a relatively high cost, on a quarterly or biannual basis. Infrequent stack tests threaten both utility operators and regulators. Utility operators may worry that one high stack test could be used as evidence of continuous non-compliance with emissions limits, while regulators may be concerned that stack tests do not provide adequate monitoring of sulfuric acid mist emissions and could fail to identify non-compliant facilities.

III. Uncertainty and Balancing

As EPA seeks more stringent regulation of other air pollutants, the utility industry and regulators will need to keep close tabs on sulfuric acid mist emissions. Perhaps the most vexing problem for regulators and industry alike is the uneasy relationship between sulfuric acid mist control and control of nitrogen oxides. A significant sulfuric acid mist problem first emerged, at Gavin and elsewhere, with the adoption of SCRs used to reduce nitrogen oxide emissions. When SCRs are combined with high-sulfur coal, as they were at the Gavin plant, sulfuric acid mist emissions can increase dramatically.

In response to the now decade-old problem with SCRs, the utility industry developed low-acid conversion catalysts that reduce the sulfuric acid conversion rate.[60] But SCRs still involve a trade off with generally higher emissions of sulfuric acid mist.[61] Power plants have sought to compensate for the higher sulfuric acid mist emissions with many of the control technologies described above, but several of these strategies, including WESPs and baghouses, may not be economical if used solely to control sulfuric acid mist. Sorbent injection, while typically the most economically feasible control method for sulfuric acid mist in the short term, may be insufficient to control very high levels of sulfuric acid mist emissions.



The LIFAC (limestone injected into the furnace with activation of untreated calcium oxide) sorbent injection desulfurization process. Image credit to the US Department of Energy, Office of Fossil Energy.

Following the recent regulations for hazardous air pollutants, including mercury and acid gases, power plants may increasingly turn to sorbent injection.[62] The need to control mercury and acid gas may have a positive impact on sulfuric acid mist control because power plants may not only invest in superior sorbent injection systems, but may also install baghouses that increase the effectiveness of sorbent controls.[63] Additional controls that target sulfur dioxide, including scrubbers, should also serve to reduce sulfuric acid mist emissions.

In the current regulatory landscape, optimizing the performance of coal-fired power plants and ensuring that they run efficiently within permit limits is increasingly difficult. Finding the operational "sweet spot" at power plants may require a significant investment of time and money. In order to reduce sulfuric acid mist emissions and balance other regulatory requirements, enforcement authorities and the utility industry must develop control strategies tailored to individual power plants. Regulators must allow time for calibration of sulfuric acid mist and other air pollutant control strategies and stack testing. For their part, plant operators must think ahead and consider the impacts of implementing control schemes for multiple pollutants. In an environment of regulatory uncertainty, it may be worthwhile for the utility industry to consider adopting conservative control strategies with multi-pollutant control benefits that increase operational flexibility, reduce the risk of future non-compliance, and anticipate the possibility of stricter, long-term emissions limits. The high costs of control equipment, complex maintenance and operation schedules of power plants, and threat of future enforcement actions leave little room for trial and error.

Update

On January 2, 2013, the US Environmental Protection Agency and the US Department of Justice announced the settlement of a sulfuric acid mist case with Kentucky Utilites Company. This was the first case resolved by the DOJ that directly addresses sulfuric acid mist in a stand-alone enforcement case.

The complaint and consent decree for US v. Kentucky Utilities Co. are also available.

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* Former trial attorney, United States Department of Justice, Environmental Enforcement Section. Special thanks to Meghan Keck, Tracy Perkins, and Alexandra Pressman and the staff of *Ecology Law Currents*. The opinions expressed below are my own and do not represent the views of my current or former employers or clients.

[1] Sulfuric acid mist is often referred to either as H_2SO_4 (sulfuric acid) or SO_3 (sulfur trioxide). Sulfur trioxide forms in power plants as the result of oxidation of sulfur dioxide; as it cools, sulfur trioxide rapidly binds with water vapor in the stack to form H_2SO_4, a liquid aerosol. *See* U.S. ENVTL. PROT. AGENCY, OFFICE OF POLLUTION PREVENTION & TOXICS, *Emergency Planning & Community Right-to-Know Act Section 313, Guidance for Reporting Sulfuric Acid*, EPA.GOV. Sulfuric acid mist is an air pollutant regulated pursuant to the Clean Air Act (CAA) as well as the Emergency Planning and Community Right-to-Know Act (EPCRA). 42 U.S.C. § 11001--50 (1986). Although industry contends there are no documented health impacts from dilute sulfuric acid mist, sulfuric acid is known to irritate and damage the eyes, skin, nose, and lungs. EPRI, *Chemical Profile: Sulfuric Acid*, AEPSUSTAINABILITY.COM.

[2] The Cross-State Air Pollution Rule, which was recently struck down by the D.C. Circuit, would have required dramatic reductions in sulfur dioxide and nitrogen oxides. *See* EME Homer City Generation, L.P. v. EPA, No. 11-1302 (D.C. Cir. Aug. 21, 2012); U.S. ENVTL. PROT. AGENCY, *Cross-State Air Pollution Rule*, EPA.GOV (last updated Aug. 21, 2012); *Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals*, 76 Fed. Reg. 48208, 48296 (Aug. 8, 2011); *Federal Implementation Plans for Iowa, Michigan, Missouri, Oklahoma, and Wisconsin and Determination for Kansas Regarding Interstate Transport of Ozone*, 76 Fed. Reg. 80760 (Dec. 27, 2011); *Revisions to Federal Implementation Plans To Reduce Interstate Transport of Fine Particulate Matter and Ozone*, 77 Fed Reg. 10324 (Feb. 21, 2012); *Revisions to Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone*, 77 Fed. Reg. 103242 (Feb. 21, 2012). Sulfur dioxide (SO_2) reductions, which can be achieved through installation of scrubbers or use of lower sulfur coals, are likely to also reduce sulfuric acid mist. Nitrogen oxide reductions, including installation of selective catalytic reduction devices (SCRs), are likely to exacerbate sulfuric acid mist emissions. The new utility hazardous air pollutant rule, the Mercury and Air Toxics Standards (MATS), may also result in reductions of sulfuric acid mist because it imposes lower emissions limits on mercury and acid gases, which may be controlled using the same controls currently used to reduce sulfuric acid mist emissions. *See* *National Emission Standards for Hazardous Air Pollutants from Coal and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units, Final Rule*, 77 Fed. Reg. 9304 (Feb. 16, 2012) . Power plant operators must also consider the impacts of new and proposed regulations relating to greenhouse gas emissions. *See Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, Proposed Rule*, 77 Fed. Reg. 22392 (April 13, 2012); *Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule*, 75 Fed. Reg. 31514 (June 3, 2010).

[3] *See* Mark Pastore, *Continuous SO_3 Monitoring Can Reduce Sorbent Consumption*, COAL POWER MAGAZINE (Feb. 1, 2011) ("SCRs serving another 150 GW are expected to be installed on U.S. coal-fired power plants by 2020 . . . ").

[4] *See* U.S. ENVTL. PROT. AGENCY, OFFICE OF AIR & WASTE MANAGEMENT, *Final Guideline Document: Control of Sulfuric Acid Mist Emissions from Existing Sulfuric Acid Production Units*, EPA.GOV . In June 1995, EPA modified the reporting requirements for sulfuric acid, but continued to require reporting of sulfuric acid aerosols including sulfuric acid mist. *See* EPCRA Guidance, *supra* note 1.

[5] *See* *John Amos Power Plant emitted more sulphuric acid than reported*, HERALD-DISPATCH, (Feb. 17, 2008).

[6] *See* Health Consultation, Gavin Power Plant, Agency for Toxic Substances and Disease Registry 3 (Aug. 9, 2007). Sulfuric acid mist can also cause severe corrosion to ductwork and stack liners, or anywhere else the sulfuric acid mist vapor condenses. *See* EPRI, *SO_3 Mitigation Guide Update* 1-9 (Mar. 2004); Citizens Against Pollution v. Ohio Power Co., 484 F. Supp. 2d 800 (S.D. Ohio 2007); Walter G. Wright, *Does Flue Gas Constitute a*

RCRA Imminent and Substantial Endangerment? ENVIRONMENTAL, ENERGY, AND WATER BLOG (Mar. 7, 2012) ("CAP's members experienced watery eyes, burning throats, headaches, and breathing problems during plume touchdowns."); EPRI, *Chemical Profile: Sulfuric Acid, supra* note 1 ("Sulfuric acid fumes can irritate eyes, skin, and breathing passages, and concentrated fumes can permanently damage the nose and lungs.").

[7] *See* Nicole Cohen, *A Disappearing Town in the Shadow of Big Coal*, NATIONAL PUBLIC RADIO, (Apr. 4, 2012).

[8] American Electric Power pioneered the use of dry sorbent controls for sulfuric acid mist. *See* Douglas P. Ritzenthaler, *SO_3 Control: AEP Pioneers and Refines Trona Injection Process for SO_3 Mitigation*, COAL POWER MAGAZINE (Mar. 1, 2007).

[9] *See* U.S. v. Hoosier Energy Rural Elec. Coop., Inc., 2010 WL 4250427 (S.D. Ind. July 23, 2010); In re E.ON U.S. & Ky. Util. Co., Notice of Violation, Mar. 19, 2009; In re E.ON U.S., Notice of Violation, Sept. 26, 2007; In re Duke Energy Corporation, Notice and Finding of Violation, Mar. 10, 2008 .

[10] *See* EPRI, *SO_3 Mitigation Guide Update, supra* note 6 ("The reaction mechanism discussed above for SO_3 formation implies that higher sulfur fuels will always produce higher flue gas SO_2 and SO_3 concentrations than lower sulfur fuels.").

[11] *See id.* at 1-3, 1-4; *see also* James T. Murphy, *SO_3 Control: How Many Coal Plants Might Have Opacity Issues Due to SO_3 Emissions?*, COAL POWER MAGAZINE (Mar. 1, 2007)(discussing various factors that influence sulfuric acid mist formation).

[12] *See* EPRI, *SO_3 Mitigation Guide* Update, *supra* note 6, at 1-4, 1-5.

[13] *See* Nenad Sarunac, *Power 101: Improving the Performance of Boiler Auxiliaries, Part II*, COAL POWER MAGAZINE (Feb. 1, 2011)(providing that "atmospheric conditions (the direction of sunlight, temperature, humidity, and wind speed)" can influence opacity from sulfuric acid mist).

[14] *See* EPRI, *SO_3 Mitigation Guide* Update, *supra* note 6, at 1-5, 1-6; EPRI, *Estimating Total Sulfuric Acid Emissions from Stationary Power Plants* 3-4–3-5 (2010)(discussing SCR's introduction of ammonia into flue gas, which can result in formation of sulfuric acid mist).

[15] *See* Murphy, *SO_3 Control, supra* note 11.

[16] Facilities that installed SCRs prior to 2005 and otherwise complied with the applicable provisions can argue that the pollution control project exemption to New Source Review applies. *See* 40 C.F.R. § 52.21. Although the pollution control project exemption has been vacated by the D.C. Circuit, the decision does not apply retroactively. *See* New York v. EPA, 413 F.3d 3 (D.C. Cir. 2005).

[17] Unlike the criteria air pollutants, there are no NAAQS for sulfuric acid mist. Because sulfuric acid mist always falls within an unclassifiable area, the prevention of significant deterioration (PSD) permitting program applies to new and modified major sources that emit sulfuric acid mist. *See* Coalition for Responsible Regulation, Inc. v. EPA, 684 F.3d 102; 2012 U.S. App. LEXIS 12980 (D.C. Cir. 2012). In *Coalition*, the D.C. Circuit rejected Petitioners' arguments that greenhouse gases were not subject to PSD because they are not air pollutants emitted from major emitting facilities. *Id.* at *64, 72–85 ("EPA's interpretation of the CAA requires PSD and Title V permits for stationary sources whose potential emissions exceed statutory thresholds for *any* regulated pollutant—including greenhouse gases. . . .[G]iven both the statute's plain language and the Supreme Court's decision in *Massachusetts v. EPA*, we have little trouble concluding that the phrase "any air pollutant" includes *all* regulated air pollutants, including greenhouse gases.").

[18] In the Gavin matter, the non-profit Citizens Against Pollution (CAP) brought a case against the Ohio Power Company (a subsidiary of AEP) under the Resource Conservation and Recovery Act (RCRA), Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA), and Emergency Planning and Community Right to Know Act (EPCRA). It appears that the non-profit brought these claims because U.S. EPA and the Ohio EPA entered into a memorandum of agreement with the power plant to reduce sulfuric acid mist emissions and CAA claims were barred. *See* Opinion and Order, Citizens Against Pollution v. Ohio Power Co., No. C2-04-CV-371 (S.D. Ohio 2007) ("OPC took measures to correct the situation, including, *inter alia*, implementing air testing and entering into an Memorandum of Agreement with the United States Environmental Protection Agency and the Ohio Environmental Protection Agency.").

[19] 40 C.F.R. § 51:166(23)(i).

[20] While there is little doubt that a significant project like the installation of nitrogen oxide pollution controls can be construed as a physical modification of a power plant, it is less clear if minor tweaks to operations trigger PSD. Power plant owners would likely contend that these tweaks were routine maintenance and that the statute's exception for "routine maintenance, repair, and replacement" applies. 40 C.F.R. § 51:166(b)(2)(iii)(a). A more interesting scenario is a situation in which the power plant has merely switched fuel sources from a low sulfur coal source to a high sulfur coal source. Making this type of switch, for instance, from 1-2 lb/MMBtu coal source to a coal source three to four times higher in sulfur content, would likely dramatically increase emissions of sulfuric acid mist (as well as sulfur dioxide). This scenario might seem an obvious trigger of EPA's PSD program because it would appear to be a change in the method of the plant's operation, but there is a specific carve-out in the PSD program for fuel switches. A fuel switch exception applies to the use of an alternative fuel that a source "was capable of accommodating before January 6, 1975." 40 C.F.R. § 51.166(b)(2)(iii)(e)(1); *see also* Hawaiian Elec. Co., Inc. v. U.S. EPA., 723 F.2d 1440, 1448 (9th Cir. 1984) (citing 1979 EPA determination that "an increase in sulfur content does not constitute use of an 'alternative' fuel").

[21] 42 U.S.C. § 7479(3).

[22] *See* Alaska Dep't of Envtl. Conservation v. EPA, 540 U.S. 461, 475–76 (2004). As the Supreme Court held in *Alaska*, "[n]othing in the Act or its implementing regulations mandates top-down [BACT] analysis.").

[23] *Id.*; *see also* U.S. Envtl. Prot. Agency, New Source Review Workshop Manual B2 (Oct. 1990). EPA maintains a clearinghouse of best available technologies for power plants and other stationary sources. *See* RACT/BACT/LAER Clearinghouse, U.S. Envtl. Prot. Agency.

[24] Determining the cost-effectiveness of BACT controls includes an assessment of the capital costs and annual operation and maintenance costs of controls and the difference between baseline emissions and controlled emissions. This allows for an approximation of the cost per ton of emissions reductions. Regulated entities also review the incremental cost of compliance, or a comparison of the costs of compliance between the best available control method and the next best method. U.S. Envtl. Prot. Agency, *PSD and Title V Permitting Guidance for Greenhouse Gases* K-1 (Mar. 2011).

[25] *See* U.S. Envtl. Prot. Agency, *EPA Region 9's PSD Permitting Process*, Epa.Gov (last updated Apr. 3, 2012).

[26] *See* U.S. Envtl. Prot. Agency, Office of Air & Radiation, *Technical Support Document: Impact on CAIR Analyses of D.C. Circuit Decision in New York v. EPA* 5, (Dec. 2005) (noting that WESP can remove approximately 95 percent of sulfuric acid mist from flue gas).

[27] The costs of a WESP are highly plant-specific and depend on plant size and configuration. The cost of capital projects for power plants is typically expressed as a function of cost per kilowatt of energy. The estimated capital costs for WESP's range from $20 to $45 per kilowatt, which, for a 2500 megawatt power plant, would translate to a cost of $50 million to $112 million. *See* John Caine & Hardik Shah, *Membrane WESP – A Lower Cost Technology to Reduce PM 2.5, SO_3 & HG_{+2} Emissions* (2006); *see also* Gary M. Blythe, et al., *Economic*

Comparison of SO_3 Control Options for Coal-Fired Power Plants, NETL.DOE.GOV. (Nov. 25, 2003). Blythe estimates that the capital costs to retrofit a plant and install a WESP would be $40 to $90, for a total cost of $100 to over $200 million for a 2500 megawatt power plant.

[28] Because BACT determinations are made on a case-by-case basis, there is no bright line rule regarding the economic feasibility of per ton pollutant removal costs. *See* Brandon A. Mogon, *The BACT Analysis Guide: Cost Analysis Considerations*, THE BACT ANALYSIS GUIDE, (Oct. 23, 2009)("Each regulatory agency has a different opinion about the maximum economically feasible cost effectiveness value, and many (e.g., CTDEP) will not tell you what that value is."). But some states have provided guidance that the general rule of thumb for the upper bound of economic feasibility for per ton reduction of pollutants approaches $4,000 to $6,000. *See, e.g.*, MASS. DEP'T OF ENVTL. PROT., *Best Available Control Technology Guidance* 6 (June 2011); NEB. DEP'T OF ENVTL. QUALITY, *Best Available Control Technology*; UTAH DEP'T OF ENVTL. QUALITY, *Best Available Control Technology*. Maximum removal costs should, in theory, relate to pollutants' proportional threat to the environment and human health with more harmful pollutants having a higher cost per ton threshold of feasibility under BACT than more innocuous air pollutants.

[29] *See* EPRI, *Estimating Total Sulfuric Acid Emissions from Stationary Power Plants, supra* note 14, at 3-6.

[30] *See* EPRI, *SO_3 Mitigation Guide* Update, *supra* note 6, at 1-7, 2-13, 4-2; *see also* EPRI, SO_3 MITIGATION: CURRENT UTILITY OPERATING EXPERIENCE A19 (2006).

[31] Residence time is the amount of time that sorbent is present in the gas stream and has an opportunity to bind with sulfuric acid mist and form a precipitate. Injecting the sorbent before the electrostatic precipitator also increases residence time. *See* Douglas Ritzenthaler, *SO_3 Control: AEP Pioneers and Refines Trona Injection for SO_3 Mitigation*, COAL POWER MAGAZINE (Mar. 1, 2007); *EPRI, Estimating Total Sulfuric Acid Emissions from Stationary Power Plants, supra* note 14, at 3-6, 4-19.

[32] *See* EPRI, *SO_3 Mitigation: Current Utility Operating Experience, supra* note 30, at 3-19 ("Performance testing completed by the manufacturer of the catalyst actually showed less than 0.1 percent SO_2 conversion to SO_3 from three different reactor tests.").

[33] *See* EPRI, *SO_3 Mitigation Guide Update, supra* note 6, at 2-19 (noting that the effectiveness of fuel blending can be difficult to predict, but one facility reduced its sulfuric acid mist emissions to zero by switching to low sulfur, Powder River Basin coal). The economics and cost effectiveness of switching coal can be very site-specific because switching or blending fuels depends on long-term coal contracts, coal availability, and other plant-specific factors. *Id.*; *see also* Gary M. Blythe et al., *SO_3 Control Options for Coal-Fired Power Plants, supra* note 27, at 2.

[34] Baghouses are air pollution control devices that remove particulates from flue gas streams. Baghouses typically use fabric filters to remove and collect dust from the flue gas stream. *See* John H. Turner, et al., *EPA Air Pollution Control Cost Manual*, U.S. ENVTL. PROT. AGENCY (Jan. 2002).

[35] *See* EPRI, *Estimating Total Sulfuric Acid Emissions from Stationary Power Plants, supra* note 14, at 4-19.

[36] *See EPA Air Pollution Control Cost Manual supra* note 34, at 1-1.

[37] Despite their high operation and maintenance costs, WESPs may compare more favorably with sorbent injection over the long-term, especially if used year-round. *See* EPRI, *SO_3 Mitigation Guide* Update, *supra* note 6, at 3-37.

[38] 40 C.F.R. § 60.42; 40 C.F.R. § 52.01 *et seq.*

[39] *See Sierra Club v. Georgia Power Co.*, 443 F.3d 1346, 1350 n.4 (11th Cir. 2006).

[40] 40 C.F.R. § 60.42(a)(2).

[41] 401 KAR 61:015(4); 40 C.F.R. § 52.920.

[42] 30 TEX. ADMIN. CODE § 111.111(a)(1)(A) (2011); 40 C.F.R. § 52.2270(c).

[43] *See* Pastore, *Continuous SO_3 Monitoring Can Reduce Sorbent Consumption, supra* note 3, at 1 ("SO_3 also creates a visible blue-white plume at concentrations as low as 3-4 ppm and is often detectable on an opacity monitor."); *but see* Sarunac, *Power 101, supra* note 13 ("Flue gas SO_3 concentrations of about 10 ppm_v can result in plume opacities greater than 50 percent in some cases; at 5 ppm_v, the opacity is about 20 percent. The specific SO_3 concentration at which a blue plume can be seen is a function of atmospheric conditions and stack characteristics. However, it is generally accepted that if the SO_3 concentration is less than 5 ppm_v, there are no visible discoloration effects.").

[44] *See* EPRI, *SO_3 Mitigation Guide Update, supra* note 6, at 1-3.

[45] *See* EPRI, *SO_3 Mitigation: Current Utility Operating Experience, supra* note 30; EPRI, *Estimating Total Sulfuric Acid Emissions, supra* note 14, at 3-7 ("The alkali injection system usually is operated to reduce SO_3 emissions to between 5 and 15 ppm, an optimal range to prevent formation of a visible plume"); *SO_3 Mitigation Guide Update, supra* note 6, at 1-8 (providing that flue gas concentrations of sulfuric acid mist of 10 ppm can result in plume opacities above 40 percent).

[46] *See* Pastore, *Continuous SO_3 Monitoring Can Reduce Sorbent Consumption, supra* note 3.

[47] U.S. Envtl. Prot. Agency, Stationary Source Compliance Division, *Visible Emissions Field Manual EPA Methods 9 and 22*, EPA.Gov.

[48] Method 9 inspectors are trained and recertified every six months at "smoke school," in which they observe white and black smoke plumes from a stack with opacity monitoring equipment. As part of their training, inspectors are tested on their ability to recognize different opacity levels of smoke plumes. *See, e.g.*, SMOKE SCHOOL, INC.; EASTERN TECHNICAL ASSOCIATES, VISIBLE EMISSIONS OBSERVER TRAINING MANUAL (Aug. 2004).

[49] *See National Parks Conservation Assoc., Inc. v. TVA*, 175 F. Supp. 2d 1071, 1079 (E.D. Tenn. 2001) ("Obviously, monitoring the smokestack emissions continuously with equipment capable of reliably measuring the opacity will identify many more exceedances than will be identified by an operator 'eyeballing' the smokestack emissions once a day, or less."); *Sierra Club v. Public Service Co of Colorado*, 894 F. Supp. 1455, 1459-60 (D. Colo. 1995) (citing the "relative reliability of CEM data over Method 9 data").

[50] *See* AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY, HEALTH CONSULTATION, GAVIN POWER PLANT 12 (Apr. 2007).

[51] *Id.* at 16.

[52] *Id.* at 5–6.

[53] *Id.* at 5.

[54] *Id.* at 13.

[55] The Hoosier settlement included a limit of .007 lb/mmBTU, but provided Hoosier with the option to petition for a lower limit. However, the limit could not be lower than .009 lb/mmBTU. *See* U.S. ENVTL. PROT. AGENCY, Consent Decree, U.S. v. Hoosier Energy Rural Elec. Coop., Inc. (S.D. Ind. July 26, 2010), EPA.GOV.

[56] *See* U.S. ENVTL. PROT. AGENCY *Hoosier Energy Agreement Marks 20th Settlement Under EPA's Power Plant Enforcement Initiative*, EPA.Gov (July 23, 2010).

[57] *See* EPRI, *Estimating Total Sulfuric Acid Emissions from Stationary Power Plants*, *supra* note 14, at 2-1–2-2 (discussing sulfuric acid mist measurement uncertainties).

[58] *Id.* EPA uses EPA Method 8 to test for sulfuric acid mist. The utility industry prefers the controlled condensate system method because it claims EPA Method 8 results in a positive bias for detection of sulfuric acid mist. *See id.* at 2-1; 3-7.

[59] *See* Murphy, *SO_3 Control*, *supra* note 11.

[60] *See* Sarunac, *Power 101*, *supra* note 13 (indicating that high oxidation catalysts in an SCR can double the concentration of sulfuric acid mist in flue gas; low conversion catalyst significantly reduce sulfuric acid mist conversion).

[61] *See* EPRI, *SO_3 Mitigation Guide Update*, *supra* note 6, at 1-6.

[62] The MATS for power plants sets numerical limits for mercury emissions, other hazardous metal emissions, and hydrochloric acid emissions.

[63] 77 Fed. Reg. at 9411 ("[T]he EPA agrees that DSI [dry sorbent injection] technology is proven and ready for commercial uses in controlling acid gases from coal combustion."). As described above, baghouses permit the injection of additional sorbent into the flue gas stream and increase the amount of residence time in which sorbent can bind with air pollutants. WESPs also can be used to control mercury. *See* John Caine & Hardik Shah, *Membrane WESP*, *supra* note 27, at 9.

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Your mode of describing all in this piece of writing is in fact fastidious, all be able to simply know it, Thanks a lot.

Posted by: Terry Bandy | November 21, 2013 at 11:01 PM

Very informative and helpful article. I appreciate the broad discussion regarding all aspects of sulfuric acid mist pollution control - including both the benefits and detriments that each mitigating measure presents. A very helpful article for anyone hoping to understand more about this pollutant in general and discover possibilities for regulation.

Posted by: Elise O'Dea | January 29, 2013 at 11:59 AM

"The need to control mercury and acid gas may have a positive impact on sulfuric acid mist control because power plants may not only invest in superior sorbent injection systems, but may also install baghouses that increase the effectiveness of sorbent controls." Interesting point--would there be a good set of reasons for a plant to invest in a WESP beyond capturing just sulfuric acid mist?

Posted by: AD | January 29, 2013 at 11:57 AM

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